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MONTANA FOREST TREE FUNGI—I. POLYPORACEAE

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(WITH PLATE 6)

Since September, 1911, the writer has been collecting the forest tree fungi of Montana with the view of issuing a list covering all species of importance found in the state. Each year's collecting has resulted in finding such a large number of species that it seems advisable to issue a first report confined to the Polyporaceae.

The forest tree fungi of Montana are not very well known. The earlier collectors paid little attention to this particular class of plants. A few of the most important publications dealing with Montana fungi may be enumerated. A list of fungi published by Seymour[1] contains 52 species from Montana. Of these 8 were fungi of forest trees. Kelsey[2] collecting in the vicinity of Helena published a list of 74 species, of which about 14 are found on leaves or twigs of forest trees. The same author[3] published notes on nine species of Erysipheae of which 3 are on forest trees. Anderson[4] published a series of papers on the fungi of Montana

[1] List of Fungi Collected in 1884 along the Northern Pacific Railroad Proc. Boston Soc. Nat. Hist. **24**: 182–191. 1889.

[2] Notes on the Fungi of Helena, Mont. Jour. Mycol. **5**: 80–82. 1899.

[3] Study of Montana Erysipheae. Bot. Gaz. **13**: 285–288. 1889.

[4] Brief Notes on a Few Common Fungi of Montana. Jour. Mycol. **5**: 30–32. 1889.

Supplementary Notes. Jour. Mycol. **5**: 82–84. 1889.

A Preliminary List of the Erysipheae of Montana. Jour. Mycol. **5**: 188–194. 1889.

A New Fomes from Northern Montana. Bot. Gaz. **16**: 114. 1891.

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in which 80 species are menioned, of which number about 13 are fungi of forest trees. Short papers by Ellis and Anderson,[5] Ellis and Everhart,[6] and Ellis and Galloway[7] mention 25 species from Montana, of which about 3 are on stems of shrubs or trees. Griffiths[8] in a series of publications on western fungi in which a number of species are either listed or described from Montana mentions 3 species (Erysiphaceae) on forest trees. Jones[9] enumerates over 100 species of fungi from the Flathead Lake region. Of this number, 17 are important forest tree fungi. Mention of many species may be found in the periodical literature treating certain groups and in the exsiccati. Century 44 (Montana edition) of Fungi Columbiani contains 15 species found on forest trees.

The present list contains a fairly large number of species, but it is not supposed that all the polypores of the state are yet collected. Members of the genus *Poria* and of the genus *Merulius* especially have been collected in abundance but only the species of which the identity is reasonably certain are listed at this time. Owing to the wide extension of the State of Montana to the east and west of the Continental Divide, its fungous flora embraces many species of the central as well as of the Pacific Coast states. The heavily wooded section in the northwestern part has practically the same fungous flora as British Columbia. In the plains region and dry mountain areas of the southern and eastern parts of the state, one may expect to find many of the species of the states to the south.

[5] New Species of Montana Fungi. Bot. Gaz. **16**: 45–49. *pl. 7*; 85–86. *pl. 10*. 1891.

[6] Notes on a Species of Coprinus from Montana. The Microscope **10**: 129–131. *pl. 4*. 1890.

[7] New Western Fungi. Jour. Mycol. **5**: 65–68. 1889.

[8] Some Northwestern Erysiphaceae. Bul. Torrey Bot. Club **26**: 138–144. 1899.

Contributions to a Better Knowledge of the Pyrenomycetes.—I. Bul. Torrey Bot. Club **26**: 432–444. *pl. 365, 366*. 1899.

The Common Parasites of the Powdery Mildews. Bul. Torrey Bot. Club **26**: 184–188. *pl. 358*. 1899.

The North American Sordariaceae. Mem. Torrey Bot. Club **11**: 1–134. *6 fig., 19 pl.* 1901.

Concerning Some West American Fungi. Bul. Torrey Bot. Club **29**: 290–301, 10 fig., 1902; **31**: 83–88, 17 fig., 1904; **34**: 207–211. 1907.

[9] Montana Botany Notes. Bul. Univ. of Montana No. 61, pp. 61–65. 1910.

Specimens of most of the species listed here have been carefully checked with authentic material collected by the writer in various parts of the United States and Europe. Specimens in some of the well known exsiccati in the writer's possession have been used in checking doubtful collections. Some authentic material for comparison has been generously contributed by Dr. C. H. Kauffman, Dr. H. D. House, Dr. L. H. Pennington, and Dr. J. F. Brenckle. To these gentlemen thanks are due. The authorities for the names of the plants are with a few exceptions those responsible for the specific names only. The writer desires to express his obligations to Mr. C. G. Lloyd for verifying and determining some of the more difficult species in this list. All specimens named in this list were collected and named by the writer unless otherwise indicated and are preserved in the Laboratory of Forest Pathology, at Missoula, Montana.

POLYPORACEAE

MERULIUS

Merulius aureus Fr. on *Pinus monticola;* Heron, *Larix occidentalis,* Missoula.

Merulius corium (Pers.) Fr. on *Larix occidentalis,* Evaro, *Prunus demissa,* Missoula.

Merulius lacrymans Schum. on mine timbers (*Pinus contorta*), Butte, mill yard timbers of *Pseudotsuga taxifolia,* Libby. This fungus or its wild form (*Merulius silvester*) is found rarely on decaying logs in the forest.

Merulius molluscus Fr. on *Pinus contorta,* Anaconda, *Pinus monticola,* Troy.

Merulius niveus Fr. on *Alnus tenuifolia,* Missoula, *Betula occidentalis,* Evaro, *Abies grandis,* Libby.

Merulius squalidus Fr. on *Pinus monticola,* Libby, *Picea Engelmanni,* Darby.

Merulius tremellosus Schrad. on *Betula occidentalis,* Missoula, *Pinus ponderosa,* Evaro, greenhouse timbers, Missoula.

POLYPORUS

Polyporus adustus Willd. on *Populus trichocarpa* and *P. tremuloides,* Miscoula. Common.

Polyporus albellus Peck on *Populus trichocarpa,* Darby, *P. tremuloides,* Missoula, *Betula occidentalis,* Missoula.

Polyporus amorphus Fr. on *Pinus ponderosa,* Darby, *P. contorta,* Haugan, *P. monticola,* Troy, *Picea Engelmanni,* DeBorgia, *Abies grandis,* Thompson Falls.

Polyporus alboluteus Ellis on *Picea Engelmanni,* Taft, *Laris occidentalis,* Libby, *L. Lyallii,* Hamilton, *Abies grandis,* Evaro.

Polyporus anceps Peck on *Larix occidentalis*, Evaro, *Pinus ponderosa*, Missoula.

Polyporus arcularius Batsch on *Alnus tenuifolia*, Missoula.

Polyporus aurantiacus Peck on *Pseudotsuga taxifolia*, Troy, *Abies grandis*, Darby, *Picea Engelmanni*, Sylvanite.

Polyporus benzoinus Fr. on *Tsuga heterophylla*, Taft, *Pseudotsuga taxifolia*, Darby, *Abies grandis*, Heron, *Picea Engelmanni*, Libby.

Polyporus berkeleyi Fr. on *Larix occidentalis*, Libby. It sometimes attacks the roots of living trees.

Polyporus betulinus Bull. on *Betula occidentalis*, Troy.

Polyporus borealis Fr. on *Picea Engelmanni*, Troy, *Tsuga heterophylla*, Troy, *Abies grandis*, Evaro. It is sometimes found on dead roots of living trees.

Polyporus brumalis Pers. on *Populus trichocarpa*, Darby, *Acer glabrum*, Troy.

Polyporus caesius Schrad. on *Populus trichocarpa*, Anaconda, *Salix* sp., Libby.

Polyporus cerifluus Berk. on *Populus trichocarpa*, Troy.

Polyporus chioneus Fr. on *Thuja plicata*, Darby, *Abies grandis*, DeBorgia.

Polyporus cinnabarinus Jacq. on *Betula occidentalis*, Troy, *Populus trichocarpa*, Missoula, *P. tremuloides*, Neihart. Common throughout.

Polyporus crispellus Peck on *Populus trichocarpa*, Missoula.

Polyporus crispus Pers. on *Populus tremuloides*, Libby.

Polyporus cryptopus Ellis, at base of dead *Pinus contorta*, slightly attached to the bark, Bozeman. This species is usually found on grass roots.

Polyporus dichrous Fr. on *Thuja plicata*, Troy, *Populus trichocarpa*, Missoula, *P. tremuloides*, Monarch.

Polyporus elegans Bull. on *Amelanchier alnifolia*, LoLo, *Populus tremuloides*, Neihart.

Polyporus ellisianus Murrill on *Pinus ponderosa*, Hamilton, *P. contorta*, Troy.

Polyporus floridanus Quél. on *Acer glabrum*, Evaro.

Polyporus fragilis Fr. on *Pinus monticola*, Troy.

Polyporus frondosus Fr. about roots of *Pinus ponderosa*, Missoula, *Pseudotsuga taxifolia*, Troy.

Polyporus fumosus Pers. on *Populus trichocarpa*, Missoula, *P. tremuloides*, Sioux National Forest.

Polyporus gilvus Schw. on dead stump of *Alnus trifolia*, Somers.

Polyporus glomeratus Peck on *Betula occidentalis*, Libby.

Polyporus griseus Peck on decaying trunk of *Pinus monticola*, Libby; usually found growing in the forest mould.

Polyporus leporinus Fr. on *Pinus monticola*, Libby.

Polyporus leucospongia Ck. on *Pinus contorta*, Anaconda, *Abies lasiocarpa*, Hamilton, *Larix Lyalli*, Hamilton.

Polyporus lucidus Leysser on *Pseudotsuga taxifolia*, DeBrogia.

Polyporus mollis Pers. on *Larix occidentalis*, Libby, *Abies grandis*, Evaro, *Pinus contorta*, Troy.

Polyporus osseus Kalch. on *Betula occidentalis*, Missoula.

Polyporus perennis Linn. on damp mossy ground in thick woods, Belton, Troy, and LoLo; sometimes on decaying logs.

Polyporus picipes Fr. on *Populus trichocarpa*, Missoula, *P. tremuloides*, Neihart. Common throughout.

Polyporus pubescens Fr. on *Betula occidentalis*, Darby, *Alnus tenuifolia*, Missoula, *Salix* sp., Belton. Thin forms are sometimes referred to *P. velutinus* Fr. The form of this plant known as *P. Grayii* (*P. pubescens* var. *Grayii*) is commonly associated with the type.

Polyporus radiatus Schw. on *Alnus tenuifolia*, Libby.

Polyporus rheades Pers. on *Populus tremuloides*, Libby, growing from wound in living tree.

Polyporus sartwellii Berk. on *Betula occidentalis*, Libby. This is really an abnormal form of *Polystictus hirsutus*.

Polyporus schweinitzii Fr. on *Pinus ponderosa*, at Missoula, Ashland, and Troy, *P. monticola*, Troy, *P. contorta*, Haugan, *Larix occidentalis*, Missoula and Somers, *Picea Engelmanni* at Darby, Saltese. Causes a serious root and trunk rot in living trees.

Polyporus semisupinus Berk. on *Alnus tenuifolia*, Heron.

Polyporus spumeus Sow. on *Populus trichocarpa*, Libby and Missoula. Causes a heart rot in living trees.

Polyporus stipticus Pers. on *Pinus monticola*, Sylvanite, *Pseudotsuga taxifolia*, Saltese.

Polyporus sulphureus Fr. on *Pinus ponderosa*, Libby, *Pseudotsuga taxifolia*, Darby, *Larix occidentalis*, White Fish. Fairly common. Occasionally attacks the roots of living trees.

Polyporus umbellatus Viviani. At base of *Picea Engelmanni*, Libby.

Polyporus undosus Peck on *Abies grandis*, Darby.

Polyporus volvatus Peck on *Pinus ponderosa*, Missoula, *P. contorta*, Bozeman, *Abies grandis*, Evaro, *Picea Englemanni*, Troy.

PORIA

Poria attenuata Peck on *Pinus contorta*, Sioux National Forest, *P. monticola*, Libby, *Larix occidentalis*, Thompson Falls.

Poria aurantiaca Rost. (*P. aurea* Peck) on *Pinus monticola*, Libby.

Poria callosa Fr., resupinate form of *Trametes serialis*, *Pinus ponderosa*, Florence, *P. contorta*, Libby.

Poria carbonaria B. & C. on *Pseudotsuga taxifolia*, Evaro, *Pinus contorta*, Anaconda. Apparently always on burned trunks.

Poria contigua Pers. on *Thuja plicata*, Libby.

Poria corticola Fr. on bark and wood of *Populus trichocarpa*, Missoula, *P. tremuloides*, Anaconda.

Poria fulvida Ellis on *Betula occidentalis*, Bearmouth.

Poria homaema Berk. on *Picea Engelmanni*, Evaro.

Poria laminata Murrill on *Alnus tenuifolia*, Libby. Forms extensive patches 2 to 3 feet long with a conspicuous stratose pore structure.

Poria marginella, Peck on *Picea Engelmanni*, Thompson Falls, *Pinus contorta*, Anaconda.

Poria medulla-panis (Pers.) Fr. on *Pinus monticola*, Libby, *Pseudotsuga taxifolia*, Evaro.

Poria obducens Pers. on *Picea Engelmanni*, Darby.

Poria perefusa Murrill on *Picea Engelmanni*, Troy. This is a doubtful determination but conforms to description with the exception of the host.

Poria pulchella Schw. on *Pinus ponderosa*, Missoula, *Acer negundo*, Sioux National Forest.

Poria punctata Fr. on *Betula occidentalis*, Troy and Missoula. Common.

Poria rufa Schrad. on *Pinus monticola*, Sylvanite, *P. contorta*, Boulder. Observed frequently in wide checks of fire-killed trees.

Poria sanguinolenta Schw. on *Pinus monticola*, Libby. Occasionally found in old branch knots on living trees.

Poria semisupina Berk., resupinate form of *Polyporus semisupinus* Berk., on *Alnus tenuifolia*, Evaro, *Acer glabrum*, Libby.

Poria subacida Peck on *Picea engelmanni*, Troy, *Abies grandis*, Darby, *Larix occidentalis*, Libby.

Poria subspadicea Fr. on *Pseudotsuga taxifolia*, Troy, *Pinus ponderosa*, Haugan.

Poria undata Pers. on *Abies grandis*, Darby, *Pinus contorta*, Haugan.

Poria vaporaria Pers. on *Abies grandis*, Darby.

Poria violacea Fr.. on *Pinus ponderosa*, Evaro, *Picea Engelmanni*, Libby.

Poria weirii Murrill on *Thuja plicata*, Darby, Troy, and Libby.

Poria xantha Fr. on *Pinus monticola*, Libby.

POLYSTICTUS

Polystictus abietinus Dicks. on fallen timber of all coniferous species. Sometimes found growing in wounds of living trees. Common.

Polystictus biformis Klotsch on *Populus trichocarpa*, Bearmouth, *Alnus tenuifolia*, Saltese.

Polystictus conchifer Schw. on *Ulmus Americana*, Arden.

Polystictus hirsutus Fr. on dead wood of deciduous trees and shrubs; wide range of hosts. Sometimes found on coniferous wood.

Polystictus pargamenus Fr. on *Populus trichocarpa*, Ashland, growing in wounds of living tree, on *P. tricocarpa*, Wisdom, *Salix lasiandra*, Belton. New range for this species, but the specimens are in every way typical.

Polystictus Sequoiae Copeland on *Thuja plicata*, Darby.

Polystictus versicolor Fr. on all species of hard woods throughout, occasionally on coniferous wood. The plants known as *Polystictus hirsutulus* Schw. and *P. zonatus* Fr. are also found occasionally.

FOMES

Fomes annosus Fr. on *Pinus monticola*, Trout Creek, *P. ponderosa*, Libby, *P. contorta*, Sylvanite, *Larix occidentalis*, Libby, *Populus trichocarpa*, Troy. Parasitic on the roots of living trees and continues to live after the death of the host.

Fomes applanatus Pers. The typical European form with brown soft crust on *Populus tremuloides*, DeBorgia. *Fomes leucophaeus* Mont., the typical American form with a pale or white hard crust, is very abundant and has been collected on *Populus trichocarpa* and *P. tremuloides* throughout the range

of these trees in the state. The fungus also occurs on *Populus angustifolia*, Sioux National Forest, *P. deltoides*, Missoula, *P. balsamifera*, Bearmouth, *Betula occidentalis*, Libby, *Abies grandis*, Taft, *Pseudotsuga taxifolia*, Darby. The fungus is frequently found on dead roots of living deciduous trees.

Fomes conchatus Pers. on *Betula occidentalis*, Somers, *Salix bebbiana*, Florence, *Populus trichocarpa*, Troy. The form *Fomes salicinus* Bull. is occasionally found on *Salix* species.

Fomes ellisianus Anderson on living *Shepherdia*, Sioux National Forest. Common.

Fomes everhartii Ellis on living trunks of *Populus trichocarpa*, Troy.

Fomes fomentarius Linn. on *Betula occidentalis*, Troy, *Populus trichocarpa*, Neihart, *P. tremuloides*, Missoula. The form sometimes distinguished as *Fomes lobatus* Schw. occurs.

Fomes fraxinophilus Peck on *Fraxinus* sp., Sioux National Forest, on roots of living trees.

Fomes igniarius Linn. on *Betula occidentalis*, Missoula, *Alnus tenuifolia*, Missoula, *Prunus emarginata*, Somers, *P. demissa*, Bearmouth, *Acer glabrum*, Libby, *Populus tremuloides*, Monarch, *P. angustifolia*, Glendive, *P. trichocarpa*, Troy. The fungus causes a serious heart rot in the living tree and continues alive after the death of the host.[10] The form "*nigricans*" is occasionally found.

Fomes juniperinus Schrenk. One specimen on living *Juniperus communis* may be referred to this species, Madison National Forest.

Fomes officinalis Fr. on *Larix occidentalis*, Kalispell and Missoula, *Pinus ponderosa*, Missoula and Evaro, *Pseudotsuga taxifolia*, Missoula. Causes a serious heart rot in the living tree and remains living after the death of the host, often fruiting in Poria-like form.

Fomes pini (Brot.) Lloyd on *Pinus ponderosa*, Neihart, *P. contorta*, Anaconda, *P. flexilis*, Anaconda, *P. albicatus*, Hamilton, *P. monticola*, Troy, *Picea Engelmanni*, Saltese, *Abies grandis*, Troy, *A. lasiocarpa*, Libby, *Larix occidentalis*, Missoula, *Pseudotsuga taxifolia*, Missoula, *Tsuga heterophylla*, Troy, *Thuja plicata*, Libby. *F. pini* causes a serious heart rot in the living tree and remains living after the death of the host. *Trametes Abietis* Karst. and *T. piceina* Peck are thin forms and from observations of the same plants during different seasons have perennial sporophores which may be stratified at point of attachment and should be here referred. All forms show great variation in pores, produce the same rot, and may be resupinate. *F. pini* sometimes occurs in entirely resupinate form. In this region the thin forms are not any more common on spruce than on other conifers. A plant repeatedly collected in Montana and throughout the Northwest and which occurs only on Crataegus has been reported as belonging in this group.[11] Recently specimens were sent to Lloyd who transmitted the following note to the

[10] Hartig. Zersetzungserscheinungen p. 115. 1878.

Spaulding. Bureau of Plant Industry Bul. **147**: 31. 1909; and in Science **28**: 816. 1908.

[11] Weir, J. R. Notes on Wood-destroying Fungi Which Grow on Both Coniferous and Deciduous Trees.—I. Phytopathology **4**: 272. 1914.

writer: "*Trametes piceana*. On Crataegus. This species is common on

acerous wood but unrecorded on frondose. Exactly same as acerous form (form with small pores). Spores globose, 5–6 mic, hyaline, transparent, often guttulate. Setae are rare but large and same as those on acerous wood. (Cfr. Syn. Fomes, p. 277.)"

Fomes pinicola Swartz. on *Larix occidentalis,* Missoula, *L. Lyallii,* Hamilton, *Tsuga heterophylla,* Troy, *Picea Engelmanni,* Libby, *Pseudotsuga taxifolia,* Missoula, *Abies grandis,* Darby, *A. lasiocarpa,* Libby, *Pinus ponderosa,* Evaro, *P. contorta,* Anaconda, *P. albicaulis,* Hamilton, *P. flexilis,* Anaconda, *P. monticola,* Troy, *Betula occidentalis,* Troy, *Alnus tenuifolia,* Libby. Occasionally causes a heart rot in the living tree, ordinarily on fallen timber.

Fomes pomaceus Pers. on *Prunus Virginiana,* Troy, *P. emarginata,* Somers, on domestic plums, Missoula. Causes a decay of the heartwood in living trees. Remains living after the death of the host.

Fomes putearius Weir on *Larix occidentalis,* Troy, *Picea Engelmanni,* Libby. A resupinate form also occurs.

Fomes ribis Schum. on living *Lonicera involucrata,* Libby, *Symphoricarpos racemosus,* Billings. The writer's specimens of *Fomes Lonicera* Weinm. and *F. Evonymi* Kalch. collected in Europe can not be distinguished in their microscopic details from *F. ribis* and should be here referred. Brenckle reports *F. ribis* as common on *Symphoricarpos* in the Dakotas.

Fomes roseus A. & S. on *Pseudotsuga taxifolia,* Darby, *Pinus contorta,* Boulder, *Picea Engelmanni,* Libby.

Fomes scutellatus Schw. on *Amelanchier alnifolia,* Libby.

TRAMETES

Trametes carnea Nees on *Pseudotsuga taxifolia,* Missoula, *Tsuga heterophylla,* Troy and Boulder, *Pinus ponderosa,* Ashland. Sporophores sometimes remain living for more than one season and are then indistinctly stratified but are quite distinct from *Fomes roseus.* A specimen on *Pinus monticola,* Troy, has a surface of whitish appressed fibrils. This form has been distinguished by the name *Trametes arctica* Berk. (See Lloyd's Synopsis of the Genus Fomes, page 225.)

Trametes hispida Bagl. on *Populus* and *Salix* spp. throughout the state. These specimens are in every way identical with material collected by the writer on *Fraxinus* in Bavaria. A form with small pores common in Europe is also occasionally found here.

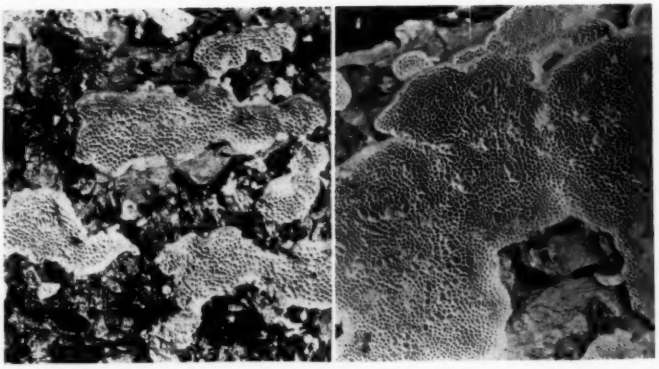
Trametes lacerata Lloyd on *Alnus tenuifolia,* Evaro, fide Lloyd.

Trametes malicola B. & C. on *Populus tremuloides,* Sioux National Forest.

Trametes mollis Fr. on *Betula occidentalis,* Bearmouth, *Populus trichocarpa,* Libby.

Trametes pargamenus Lloyd. Mr. Lloyd named this species from material collected by the writer on living *Populus trichocarpa,* Darby. It "is a thick, rigid plant, but in other features, context, violaceous pores, etc., is the same species" as *Polystictus pargamenus.* (See Lloyd Letter.)

Trametes protracta Fr. on *Pinus monticola,* Libby, *P. contorta,* DeBorgia. This is a good species and should not be considered a poroid form of *Lenzites saepiaria.* In its typical form the species is much larger than the latter, sometimes 3 to 4 by 6 inches, smooth above and is usually found on pines.



LENZITES HETEROMORPHA Fr.

Trametes sepium Berk. on *Acer negundo*, Sioux National Forest. A plant is occasionally collected from old yellow pine stumps which is in every way typical and should be referred here.

Trametes serialis Fr. on *Pinus ponderosa*, Boulder, *P. contorta*, Anaconda, *P. monticola*, Troy.

Trametes suaveolens Fr. on *Populus trichocarpa*, Missoula, *P. tremuloides*, Monarch, and on various *Salix* spp. throughout the state. The species sometimes causes a heart rot in living trees.

Trametes tenuis Karst. (*T. setosus* Weir), on *Pinus monticola*, Troy, *P. ponderosa*, Darby, *Larix occidentalis*, Evaro.

Trametes variiformis Peck on *Larix occidentalis*, Darby.

DAEDALEA

Daedalea unicolor Fr. on deciduous trees, common throughout the state. A light colored form of this species is designated by Lloyd as *D. ochracea*. Hennings recognized an Irpex-like form as *D. unicolor* var. *hydnoidea*. Both forms are common on birch.

Daedalea confragosa Fr. on *Salix* sps., Missoula, and Neihart, *Populus tremuloides*, Libby. All the usual variations occur.

LENZITES

Lenzites saepiaria Fr. on all species of conifers and occasionally on wood of deciduous trees, rarely a wound parasite. Common throughout the state.

Lenzites betulina Fr. on dead wood of *Betula occidentalis*, Libby.

Lenzites heteromorpha Fr. on *Pseudotsuga taxifolia*, Evaro, *Abies grandis*, Libby, *Tsuga heterophylla*, Troy, *Pinus monticola*, Heron. These specimens are probably only in part correctly referred. The material shows great variation. The plant is coarse, white with white context and the hymenium may be either lamellate, daedaloid, or with large angular pores 0.4 to 1 cm. deep and 2 to 5 mm. broad. The spores are hyaline 8–11 by 3–4 μ. This plant or a closely related form seems to have been named *Trametes hexagoniformis* by Murrill. A specimen sent to Mr. Lloyd has been so referred. The accompanying photographs (*pl. 6*) show quite plainly the form variations of this plant on *Pseudotsuga taxifolia*.

Lenzites trabea Fr. on *Betula occidentalis*, Haugan, *Prunus demissa*, Libby, *Pinus contorta*, Boulder.

FAVOLUS

Favolus europaeus Fr. on dead branch of *Fraxinus viridis*, Glendive; small weathered specimen but typical except color.

OFFICE OF INVESTIGATIONS IN FOREST PATHOLOGY,
BUREAU OF PLANT INDUSTRY,
MISSOULA, MONTANA.

THE RATE OF GROWTH AND ECESIS IN LICHENS[1]

BRUCE FINK

One frequently sees statements concerning the rate of growth in lichens; but these are based, with few exceptions, on uncertain observations rather than on measurements. Aside from results obtained in cultures, the exceptions are a few measurements in Lotsy, J. P., "Beiträge zur Biologie der Flechtenflora des Hainbergs bei Göttingen" (1890) and Howe, R. H., Jr., "Aspects of New England lichens" (1908). In order to obtain sufficient data for a safe conclusion regarding the rate of growth and ecesis in lichens, the writer began a series of studies near Oxford, Ohio, and another near Big Hill, Kentucky, during the summer of 1908. At the request of a number of botanists, a preliminary statement about the work near Oxford, Ohio, was given in "Lichenoecological studies from Beechwood Camp," published in *The Bryologist* for March, 1909. During 8 years ending with the summer of 1916, the lichens under observation had developed to such an extent, for most of the studies, that nothing would be gained by further observation. Therefore, the time has come for a final report, which may be supplemented later by recording further observations from a few of the areas.

The studies near Oxford, Ohio, may be summarized thus: 17 for rate of growth, 18 for rate of primary succession, and 18 for rate of secondary succession. Those near Big Hill, Kentucky, are 20 for rate of growth, 20 for primary succession, and 17 for secondary succession. The succession studies also furnished valuable data on the rate of growth. Of 107 studies begun, 45 are reported herein. For various reasons, the other 62 studies gave no results worth recording. Some of them were destroyed before valuable results could be obtained, while a few ran the whole 8 years without giving data of sufficient value to warrant publication. Some of the succession studies reverted to the con-

[1] Contributions from the Botanical Laboratory of Miami Univerity,—XIII.

ditions surrounding them before the 8 years had expired; 1 was destroyed by erosion; 1 was lost because of poor marking; others were destroyed through human agency; in 2 instances there was total lack of succession on chipped-rock surfaces. Of the studies of rate of growth, some of the plants under observation disappeared through destruction of the substrata on which they were growing, or through various other forms of natural or human interference. In 3 instances the plants ceased to grow soon after they had been marked; in other 3 instances the logs on which the lichens were growing were destroyed; in 5 instances the plants began to deteriorate soon after they had been marked, or possibly before the marking was done; in 4 instances the rocks on which the plants were marked disintegrated rapidly; and in 3 instances the plants appeared healthful for a long period, but failed to grow nevertheless. Though so large a proportion of the studies suffered through various vicissitudes, the 45 reported herein contain data sufficient for our purpose.

The observations were made in the Ohio area in 7 of the 8 years during which the studies ran, omitting a year after the fifth of the series of observations and another after the sixth. The results proved that the added data scarcely justified the labor involved in making observations so frequently. Consequently, in the Kentucky area, which was reached by a journey of 175 miles, 2 years were allowed to pass without observing after the second series of observations and 3 years after the third series. This gave 7 series of observations for the Ohio area and 4 for the Kentucky area. The dates of observation for the Ohio area are August 4 to 13, 1908; August 1 to 9, 1909; July 31 to August 5, 1910; July 29 to August 3, 1911; July 31 to August 4, 1912; July 11 to 18, 1914; and September 1 to 7, 1916. The dates for the Kentucky area are October 23 to 30, 1908; August 20 to 27, 1909; September 3 to 6, 1912; and August 24 to 26, 1916. Ten of the studies in Ohio were begun in 1909. Only 6 observations were made on these.

The number of sets of data for each study recorded below corresponds with the number of observations that showed changes worth recording, before the study was destroyed in some manner, before it reached a stage of development after which further

study was of no value, or before the observations were completed for the series as a whole. In the Ohio area, where the observations were made more frequently than was necessary for most of the studies, the number of sets of data for each study often does not reach the number of observations made. In the Kentucky area, the number of sets of data recorded for each study usually reaches the whole number for the area, except when the study was destroyed in some manner.

Where 2 or 3 studies lay side by side on a substratum, the same number was used for the areas, followed by (*a*) or (*b*) to indicate the second or the third of the series lying contiguously. In the Ohio area, 2 sets of numbers were used, unfortunately, 1 for the studies of rate of growth and the other for the succession studies. This accounts for the duplication of numbers for this area.

The areas are grouped below, not according to locality, but according to character of the studies and after this according to the plants involved, passing from lower to higher with respect to somatic structure.

Such expressions as 25 by 31 cm. across refer to a minimum and a maximum distance across the plant and indicate nothing regarding the form of the plants involved.

Statements regarding shade caused by trees refer of course to conditions while the leaves were on the deciduous trees.

Lichen rhizoids are known to penetrate from 0.02 to 1.4 cm. into rock; but the algal-host cells have never been found deeper than 0.5 mm. Though the rhizoids may have penetrated deeper in some instances than the rocks were chipped in our areas tabulated under primary successions, the algal hosts were certainly removed in every instance. Consequently, any remnants of the lichen rhizoids that may possibly have been left in the rocks in any instance, through failure to chip deeply enough, probably died, and the successions recorded as primary are all of this character beyond reasonable doubt.

RATE OF GROWTH

Ohio, area 20, on the north side of a tulip tree 22 cm. in diameter, in a low, shady wood. A well-fruited specimen of

Graphis scripta, situated 1.3 m. from the ground, was 2 by 3.5 cm. across. After 1 year the plant was 3 by 4 cm. across.

Ohio, area 5, on the north side of a maple tree 16 cm. in diameter, growing along the north side of a high wood, where shaded except late in the afternoon. A well-fruited specimen of *Graphis scripta,* situated 1.6 m. from the ground, was 1 cm. across. After 1 year the plant was 1.2 cm. across. After 2 years it was 1.5 cm. across.

Ohio, area 21, over a mossy rock along a brook, in a low, moist wood, well shaded. A specimen of *Peltigera canina* 10 by 14 cm. was deprived of several large apothecia. The lobes all pointed in the same direction, and the plant grew 1.75 cm. in this direction in 1 year. The area deprived of its apothecia produced 12 young apothecia, of which only 1 was sufficiently developed at the end of the first year to show the brown disk. From 2 plants near by, the lobes were all removed, leaving the plants 2 and 5 cm. across the longest way. After 1 year the lobes were so completely regenerated that one would not know that they had been amputated. The plants were, at this time, 3.5 and 6 cm. across the longest way.

Kentucky, area 1, a quadrat 10 cm. square, situated on a sandstone ledge about 200 m. above the surrounding country, the dry rock face making an angle of 45 degrees with the horizon, and exposed to the sun during the middle of the day. Thirty plants of *Umbilicaria pustulata* were measured. After 10 months 1 minute, smooth, sterile plant had increased from 1 to 3 mm. in average diameter, while other smooth, sterile plants had increased as follows: 1 to 2 mm., 5 to 6 mm., 6 to 7 mm., 3 to 3.1 mm., 2 to 2.4 mm., 8 to 9 mm., and 6.5 to 9 mm. There were no fruited or conspicuously pustulate plants in the quadrat at this time. After 8 years the plants that remained in the quadrat were stronly pustulate and bore many apothecia. Many of the plants marked in the first study had disappeared, and younger plants had appeared in their places.

Ohio, area 4, on next to the top rail of a fence along the north border of a high, dry wood, well shaded except late in the afternoon. A smooth and sterile specimen of *Parmelia borreri* 25 cm. in diameter was marked. After 1 year the plant was 26.3

cm. in diameter and showed a few isidioid branchlets. During the second year the increase in size was about the same, and the central, oldest portion of the plant had developed many isidioid branchlets.

Kentucky, area 31, on a sandstone boulder on high, open ground, the boulder 1 by 1.5 m. across, 1 m. high, the upper surface making an angle of 10 degrees with the horizon and facing southward. Five plants of *Parmelia conspersa,* growing on the upper surface, were marked. They varied from 1 to 2 cm. across. After 10 months the plants varied from 1.5 to 2.2. cm. across. After 4 years the sizes ranged from 2.5 to 4 cm. across.

Kentucky, area 3, on the northwest side of the perpendicular face of a sandstone-conglomerate outcrop 2 m. high, standing on a high, dry, sparsely-wooded hill, where shaded until the middle of the afternoon. Two plants of *Parmelia conspersa* 40 cm. from the ground and 1 and 3 cm. across respectively were marked. After 10 months they had increased to 1.5 and 3.5 cm. across. After 4 years the plants were 3 and 7 cm. across. Both specimens were sterile throughout the 8 years of observation, and they did not grow perceptibly during the last 4 years.

Kentucky, area 6, habitat similar to Kentucky, area 3,[2] but the plants 75 cm. from the ground. Two specimens of *Parmelia conspersa* were marked, both sterile and smooth, and 1.4 and 4 cm. across, respectively. After 10 months the plants were 2.5 and 5 cm. across. After 4 years they were 3 and 8 cm. across. The plants remained smooth and sterile during the 8 years of observation; and they deteriorated toward the close of the period so that further observations could not be made.

Ohio, area 19, on a tulip tree, 22 cm. in diameter, in a low, moist wood, furnishing shade. A smooth and sterile *Parmelia caperata,* situated 1.4 m. from the ground, measured 3.5 by 4 cm. across. After 1 year the plant was 3.75 by 4.8 cm. across and still smooth and sterile.

Ohio, area 6, habitat similar to Ohio, area 5,[3] but 1.4 m. from the ground on the northwest side of the tree. The specimen of *Parmelia conspersa* studied was 1.5 cm. across when marked.

[2] See the area discussed next above.

[3] See Ohio, area 5, p. 141.

After 2 years it was 2 cm. across in one direction and 2.4 cm. across at right angles. After 3 years the plant was 2.6 and 2.9 cm. across in the 2 directions respectively.

Ohio, area 7, habitat similar to Ohio, area 5,[4] but only 0.2 m. from the ground on the north side of the tree by a little east. The specimen of *Parmelia conspersa* studied was smooth and sterile and 1 by 1.6 cm. across. After 1 year the plant was 1.3 by 1.9 cm. across. After 2 years it was 2.1 by 3 cm.; after 3 years, 3.5 by 4.1 cm.; after 5 years, 4.5 by 5 cm.; after 7 years, 7 by 8 cm.; and after 8 years, 10.2 by 12.9 cm. across. After 7 years the central portion of the thallus, about 2 cm. across, bore scattered isidioid branchlets, which increased in number and area covered during the following year.

Ohio, area 3, on next to the top rail of a fence, well shaded by a mesophytic wood, except late in the afternoon. A smooth and sterile specimen of *Parmelia caperata* 1.2 cm. across was marked. After 1 year the plant was 1.75 cm. across. After 2 years, 3 by 3.5 cm.; after 3 years, 5 cm.; after 4 years, 5.7 by 6.5 cm.; after 6 years, 7.3 by 9 cm.; and after 8 years, 10 by 13 cm. across. At the conclusion of the observations the central portion of the thallus half way to the margins was thickly covered with isidioid branchlets.

Ohio, area 1, on the northwest side of a rail lying on the ground, along the north border of a high, dry wood, well shaded except late in the afternoon. A quadrat of *Cladonia pityrea* 10 by 16 cm. was marked. No podetia were present in the quadrat, and the horizontal thallus consisted of small or minute, scattered squamules, many of them too small to be seen with the eye. After 2 years the quadrat was thickly covered with squamules of normal size for the species, and many podetia had appeared. A large proportion of these were detected under the hand lens, but 19 were visible to the eye and varied from 2 to 4 mm. long

Ohio, area 22, on a hornblende boulder 2.5 by 4 cm., and 2 cm. high, the upper surface facing westward at an angle of 30 degrees with the hroizon and well shaded, except for an hour shortly before mid-afternoon. A specimen of *Physica pulverulenta* and one of *Parmelia conspersa* were marked. The plants were 2.4 by

[4] See Ohio, area 5, p. 141.

2.7 cm. and 1.9 c.m across respectively. After 1 year the *Physcia* was 2.75 by 3.1 cm. and the *Parmelia* 2.65 cm. across. After 2 years the *Physcia* was nearly circular and 3.6 cm. across, and the *Parmelia* was 3.5 cm. across. After 3 years the *Physcia* was 3.7 by 4 cm. and the *Parmelia* 4.3 by 4.7 cm. across. An area 0.5 cm. across near the center of the *Parmelia* had disappeared. After 5 years the *Physcia* was 4 by 4.45 cm. and the *Parmelia* 6 by 6.5 cm. across. After 7 years the *Physica* was 5. cm. and the *Parmelia* 9.5 by 10.4 cm. across. At 5 years the lost area of the *Parmelia* had increased to 1 cm. across, but at 7 years it was completely regenerated. Both plants were sterile throughout the time of observation.

Ohio, area 16, on the trunk of a beech tree 20 cm. in diameter, standing in a low, shaded wood. An area of *Amphiloma lanuginosum* 3.3 by 4.1 cm. across was marked. After 1 year the area had increased in size to 3.47 by 4.4 cm., but did not look thrifty. The area was found to be in a dying condition at the time of the next observation.

Kentucky, area 10, on a sandstone block 28 by 35 cm., and 10 cm. high, lying in a high, dry, open wood. Fourteen areas of *Verrucaria muralis* were marked, the largest 2.12 by 2.4 cm. across, the others averaging from 0.4 to 0.5 cm. across in various directions. After 10 months the largest plant was 2.2 by 3 cm. across, and the others averaged from 0.5 to 0.9 cm. across in various directions. The boulder disappeared before the time for the next series of observations.

SECONDARY SUCCESSIONS

Kentucky, area *7a*, habitat like Kentucky, areas 6 and 7.[5] The thallus of *Amphiloma lanuginosum* was scraped from the rock over a circular area 10 cm. in diameter until no remnants were visible to the eye. The area about the study was left with the thallus of the same plant undisturbed. After 10 months there was no evidence of ecesis. After 4 years the thallus was returning over numerous centers from 0.5 to 2 mm. across. After 8 years the returning areas covered about half of the study and

[5] See Kentucky, areas 6, p. 142, and 3, p. 142.

varied from 2 to 30 mm. across. At this time the study differed in appearance from the surrounding undisturbed area only in that the areas of thallus were more scattered.

Kentucky, area 4a, habitat like Kentucky, area 4.[6] All the apothecia of *Biatorella simplex* were taken from a quadrat 5 cm. square, using the hand lens to get the smallest ones and taking also a large proportion of the epilithic parts of the thallus. After 4 years the quadrat showed numerous apothecia, some of which were 1.5 to 2 mm. in diameter.

Kentucky, area 21, on the flat top of a sandstone block near the top of a high, dry hill, the block 1 by 1.4 m., 1.3 m. high, and lying in the sun for 4 or 5 hours near the middle of the day, but shaded during the remainder of the day by a high cliff on one side and by trees on another. A quadrat of *Ramalina calicaris* was laid out 1.5 cm. square, and the *Ramalinae* were all removed, except basal remnants about 0.1 mm. long. After 10 months several plants were found that showed no evidence of having been cut off, varying in size from those too small to be seen without the hand lens to others 0.1 to 0.2 mm. long. After 8 years there were 6 plants from 2 to 5 mm. long, all sterile.

Kentucky, area 27, at the edge of a high, dry cliff facing northward, partially shaded in the forenoon by shrubs to the south. The center of a thallus of *Parmelia conspersa* 28 by 33 cm. was taken out over an area 20 by 25 cm. across, except small fragments not easily detached from the rock. Ten areas 1 to 2.5 cm. across and many other minute areas were left. After 10 months the marginal zone of the thallus had grown outward until the distance from one side of the margin to the opposite side was 29 and 34 cm. in the two directions in which the thallus had been measured previously. The inner border of the marginal zone left undisturbed showed numerous lobes regenerated and extending inward, these lobes varying in length from 1 to 15 mm. The areas left in the denuded center showed regenerated lobes about their margins, varying in length from those barely visible under the hand lens to others 3 mm. long. Also there were many minute thalli arising over the denuded center, varying in size from those only discernible by aid of the hand lens to others from 0.5 to 1 mm. across.

[6] See Kentucky, area 4, p. 151.

These probably arose from minute remnants of the thallus left in scraping the central portion of the plant from the rock. After 4 years the areas returning over the denuded center had increased in size considerably and were beginning to overlap. After 8 years a dozen regenerated thalli had covered the denuded center, except the portions covered by the regenerated lobes which had grown inward from the marginal zone not denuded to meet and overlap these. The 12 thalli varied from 2 to 5.3 cm. across. At this time the whole area was 32.3 by 40.4 cm. across.

Kentucky, area 30, 1 m. from the top in a crevice 1.5 m. wide and extending nearly north and south through the face of a high, dry, northward-facing cliff, the crevice shaded, except near the middle of the day. The thalli of *Umbilicaria pustulata* and *Gyrophora dillenii* were removed from a circular area 4 dm. in diameter, except a few fragments about 1 cm. across, left attached by the umbilici, and 9 specimens of the former plant of about the same size. Plants of the same species were left about the study, and some of those of *Umbilicaria pustulata* bore apothecia. After 10 months the fragments showed no evidence of regeneration, and the plants left had not grown sufficiently so that any increase in size could be noted. After 4 years 15 plants were found growing in the area; but it was not possible to determine which might have arisen from regeneration and which might have represented the minute plants left when the study was plotted. The largest plant was 3.8 by 4.2 cm. across, and this and two other plants of *Umbilicaria pustulata* were sparingly covered with pustules. The other 12 plants were from 0.3 to 2.1 cm. across. After 8 years about 40 plants of the two species were found growing in the area. Fourteen specimens of *Umbilicaria pustulata* averaged 2.5 to 5 cm. across in various directions and were conspicuously pustulate. Six of them showed young apothecia from 0.2 to 0.4 mm. across. Twelve specimens of *Gyrophora dillenii* were 1.5 to 3.45 cm. across.

Kentucky, area 13, on top of a limestone rock 0.9 by 1 m. across and 20 cm. high, on a partially shaded, dry hillside, the upper surface of the rock making an angle of 60 degrees with the horizon. All the large specimens of *Dermatocarpon miniatum* were taken from a quadrat 17 cm. square, leaving many small

thalli averaging 0.25 to 9 mm. across in various directions. Some of the plants were in groups of 2 to 15 or 20; and the individual plants of the groups were often too small to be seen without the hand lens. All the plants left were sterile. After 10 months the plants had grown but little, the largest one being but 11 mm. across. After 4 years 1 plant was found 13.7 by 14.3 mm. across and another 11.3 by 12.5 mm. across. The remainder of the plants averaged for most part from 0.4 to 1.5 mm. across in various directions. All were still sterile.

Ohio, area 13, a quadrat 19 cm. square, plotted on a boulder 0.7 m. high, 2 m. from a brook in a damp wood. The quadrat was thoroughly scraped with a knife blade, and only minute particles of *Physcia endochrysea, Leptogium lacerum,* and the small number of mosses and leafy hepatics interspersed were left adhering to the surface of the rock. After 1 year *Physcia endochrysea* was returning in 30 areas, varying in size from those barely distinguishable under the hand lens to others 1 mm. across. *Leptogium lacerum* was returning in several spots in the quadrat; but the plants were visible only under the hand lens. Bryophytes were also returning and gave a green coloration to portions of the quadrat not covered by lichens; but their gross structure was distinguishable only under the hand lens. After 2 years *Physcia endochrysea* was found growing in 60 spots in the quadrat; and the plants varied from 0.2 to 1.5 cm. across. Some of them were visible 60 m. distant. The other plants showed little change. After three years the largest *Physcia endochrysea* was 1.75 cm. across, and 10 others were 1 cm. across or larger. The bryophytes covered a considerable portion of the remaining area, and the plants were as large as those surrounding the quadrat. The remainder of the quadrat was covered mainly by *Verrucaria nigrescens* sparsely fruited. Poorly developed thalli of this lichen were probably present when the quadrat was plotted, but were covered by other lichens and bryophytes and grew rapidly only after the cover plants had been removed. At this time and at later periods only 3 or 4 minute centers of *Leptogium lacerum* were found within the quadrat. After 7 years *Physcia endochrysea* and the bryophytes covered about three-fourths of the quadrant in approximately equal areas, and *Verrucaria nigrescens*

had taken the other one-fourth. The quadrat had reverted to conditions found over the remainder of the rock; for *Leptogium lacerum* had largely disappeared, while *Verrucaria nigrescens* had become conspicuous without the quadrat as well as within it. The *Physcia* was sterile both within and without the quadrat.

Kentucky, area 12, on the upper surface of a boulder 80 by 140 cm. and 30 cm. high, lying on a dry hillside, the upper surface making an angle of 35 degrees with the horizon and exposed to the sun, except during half of the forenoon. A small area of *Psora russellii* was stripped of apothecia. After 10 months the area showed 2 small apothecia. After 4 years 50 apothecia were found, some of them of average size for the species. After 8 years more than 100 apothecia were present.

Kentucky, area 14, a quadrat 30 by 40 cm. on a limestone rock 40 by 100 cm. and 75 cm. high, lying in an open, dry wood where poorly shaded, the upper surface making an angle of 15 degrees with the horizon. *Leptogium lacerum* and the moss on which it was growing were rubbed and scraped from the rock, except bits of the moss and particles of the lichen which adhered to the rock, especially in depressions of the rock surface. After 4 years the moss was found returning over 300 or more small areas, many of them bearing specimens of *Leptogium lacerum* 2 to 10 mm. across. Very little change occurred during the next 4 years.

Kentucky, area 25, a quadrat 32.5 by 45 cm. at the top of a high, dry cliff facing northward, the quadrat on bare rock at the edge of the cliff, but on soil 16 cm. deep at the opposite side, partially shaded during the forenoon by low shrubs. Many plants of *Cladonia uncialis, C. cristatella, C. fimbriata,* and *C. pyxidata* were torn and pounded from the *Polytrichum* on which they were growing, and the fragments were strewn over the quadrat. After 4 years *Cladonia uncialis* and *C. pyxidata* were both abundant and well developed with many podetia of normal form and size. After 8 years the 2 lichens had taken the quadrat, and about one-fourth of the podetia of *Cladonia pyxidata* bore apothecia.

Kentucky, area 24, habitat similar to Kentucky 25,[7] but back 2 m. from the edge of the cliff, on soil 0.5 m. deep over the rock. The quadrat, 10 by 14 cm., was covered by *Cladonia uncialis*

[7] See the area discussed next above.

growing over mosses. The *Cladonia* was removed as thoroughly as could be done over part of the quadrat, while over the remainder of its surface the upper half of each podetium was cut off, leaving the basal portion 1 to 1.5 cm. long. Over the portion from which the plants had been removed as completely as possible, the podetia were broken into small or minute fragments and worked into the mossy substratum to test the rate of regeneration. After 4 years the plants were regenerated, and *Cladonia uncialis* was as luxuriant as over surrounding undisturbed areas. The regenerated plants were particularly luxuriant over the portion of the quadrat on which the fragments had been worked into the substratum.

Ohio, area 10, a quadrat 10 cm. long on the third rail from the top of a fence in a mesophytic wood, well shaded during the forenoon and partially shaded during the afternoon. *Cladonia pityrea* covered the quadrat, and the podetia and as much as possible of the squamules were removed that the rate of ecesis or regeneration might be studied. After 1 year squamules had developed strongly, and two minute podetia were visible to the eye. After 3 years the quadrat showed many podetia from 3 to 5 mm. long.

Ohio, area 11, a quadrat 65 cm. long on the upper side of the second rail from the top in a fence along a roadside in a mesophytic wood, well shaded in the forenoon and partially shaded during the afternoon. All visible portions of the 3 or 4 species of *Cladonia* which covered the quadrat were removed, leaving the rotted surface of the rail. After 1 year squamules were returning over most of the quadrat and were of sufficient size and number to be seen at a distance of 3 m. After 3 years 40 podetia were present in a small portion of the quadrat. These were 3 to 4 mm. high, and most of them bore cups.

Kentucky, area 5a, habitat like Kentucky, areas 3 and 5. The thallus of *Cladonia subsquamosa* was taken from a quadrat 5.5 by 1.75 cm., leaving only such fragments as could not be removed from the rock surface. After 10 months a few squamules could be seen in the quadrat. After 4 years the squamules had reached normal size and number, and 50 podetia were developing. After 8 years the podetia as well as the squamules were as numerous and as large as those in surrounding undisturbed areas.

Kentucky, area 5b, habitat like Kentucky, areas 3 and 5.[8] All the podetia of *Cladonia subsquamosa* were removed from a quadrat 2 by 4.5 cm., but the squamules were left. After 10 months 35 short podetia were detected. After 4 years the podetia were numerous and of normal size.

Ohio, area 23, on the top 3 rails of 24 rail-lengths of fence, the rails mostly of sound tulip-poplar and placed in the fence in October, 1908, the area lying along a roadside where exposed to the sun, except under 2 large beech trees where shaded until mid-afternoon. After 2 years 2 minute specimens of *Parmelia tiliacea* were found on a new rail under one of the beech trees. After 6 years several *Physcia tribacia* plants were found on a new rail under one of the beech trees, the largest *Physcia* 5 by 7 mm. One *Parmelia* found 4 years before was now 2 cm. across. On another new rail under one of the beech trees, a strip of *Cladonia* squamules was found scattered over the rail for a distance of 10 cm. On a new rail exposed to the sun was found a *Cladonia* with several minute podetia. One of the new, exposed, top rails showed the thallus of *Placodium microphyllimum* scattered over the whole length of the rail. After 8 years the largest *Physcia tribacia* was 2.5 cm. across, the larger *Parmelia tiliacea* was 6 cm. across, and *Placodium microphyllinum* was found on several new rails scattered along the whole 24 rail-lengths. The last plant bore several apothecia.

Kentucky, area 23, a quadrat of soil 60 by 70 cm., denuded 3 cm. deep and some sticks devoid of lichens scattered over the quadrat, which was poorly shaded by a dry, open wood. The quadrat, before being denuded, was covered by the following plants: several areas of *Cladonia subcariosa*, an area of *C. cervicornis*, some crustose lichens on small stones, and a few mosses which covered the small proportion of the soil not covered by the *Cladoniae*. After 10 months *Cladonia* squamules were beginning to appear on the soil throughout the quadrat. These were large enough to be seen plainly with the eye. Unfortunately, the quadrat was destroyed before another observation could be made.

Kentucky, area 8, an eastward-facing ledge of conglomerate sandstone 4 m. high, lying on a high, sparsely-wooded hill,

[8] See Kentucky, area 5, p. 154, and Kentucky, area 3, p. 142.

partially shaded by shrubs on the east and by the rock face on the west, the rock projecting over the area, which is seldom reached by rain. Over a circular area of *Lecanora frustulosa* 10 cm. across and 1.8 m. from the ground, the apothecia and most of the epilithic portion of the thallus were scraped from the rock, using the hand lens to get minute apothecia and fragments of thallus. No development was detected until 8 years had passed when several small areas of thallus and a few apothecia 0.2 to 0.25 mm. across were found. The hardness of the substratum and the lack of moisture probably account for the unusually slow rate of development.

PRIMARY SUCCESSIONS

Ohio, area 15, a limestone 3.5 by 5.5 cm., largely imbedded in the soil on a northward-sloping, mesophytic hillside, the rock surface level with the soil to 2 cm. above, exposed to the sun. The upper surface, covered mainly by *Pannaria nigra* and a moss, was chipped on the side raised above the soil 1 to 2 cm. deep over a quadrat 2 by 4 cm. After 2 years 4 minute areas of *Pannaria nigra* were found within the quadrat, 2 of which bore one minute apothecium each. After 5 years many more minute lichen thalli were found in the quadrat, but they were too young to be identified. After 7 years a half dozen areas of *Pannaria nigra* were found. Apothecia were few in number. The largest thallus was 1 cm. across and bore 6 well-developed apothecia. The largest of these was 0.5 mm. in diameter.

Kentucky, area 4, habitat like Kentucky, area 3.[9] In an area of *Biatorella simplex*, a quadrat 10 cm. square was made by chipping the rocks 2 to 10 mm. deep. After 4 years many minute areas of thalli were found within the quadrat. After 8 years many minute apothecia were observed under the hand lens. The largest apothecia were 0.25 mm. across, while the largest in undisturbed areas surrounding the quadrat were 2 mm. across.

Kentucky, area 2, on a limestone 8 by 11 cm., lying on dry soil near the top of a steep, wooded hill about 200 m. high, the upper surface of the limestone lying in a horizontal plane, with one of its sides level with the soil while the opposite side was 9 cm. above the soil. *Verrucaria rupestris, Staurothele diffractella, Pyre-*

[9] See Kentucky, area 3, p. 142.

nopsis schaereri, Placodium sideritis, Collema pustulatum, and *Physcia obscura* (?) were growing on the upper surface of the rock, from which the front one-fourth and the back one-fourth were chipped 2 to 15 mm. deep. After 4 years many minute primordia of lichen thalli were found under the hand lens, within the chipped quadrats. After 8 years these quadrats were sprinkled over with minute thalli of *Pyrenopsis schaereri,* a few small thalli of *Physcia obscura* (?), and several minute and sterile ones of *Collema pustulatum.* All of these thalli were sterile; but a single specimen of *Placodium sideritis* 1.5 cm. across bore 4 minute apothecia.

Ohio, area 7, on a limestone 65 by 5 cm. and 35 cm. high, standing nearly erect in a moist, shady wood, the quadrat covering half of the 65 cm.-wide, nearly perpendicular rock face, chipped 4 to 18 mm. deep. After 2 years all of the chipped quadrat showed an indistinct green coloration, in which the hand lens revealed scattered areas turning toward the dark color characteristic of *Verrucaria nigrescens,* which had covered most of the rock surface before the quadrat was plotted. After 6 years this lichen was found over more than half of the chipped quadrat with numerous apothecia, and thallus nearly as dark as on surrounding undisturbed areas.

Kentucky, area 7, habitat like Kentucky, area 6.[10] In an area covered by *Amphiloma lanuginosum,* a circular portion 10 cm. in diameter was chipped 1 to 10 mm. deep. After 4 years the *Amphiloma* was found returning in patches averaging 0.5 to 2 mm. across in various directions and scattered over the whole area. After 8 years the plant covered about three-fourths of the surface, and a considerable number of larger patches ran from 5 to 10 mm. across in various directions.

Ohio, area 8, from a levee 1.3 m. wide and 0.3 m. high, lying 9 m. from a brook, on usually dry ground exposed to the sun, the limestone fragments composing the levee of sizes easily handled, removed a portion 70 cm. long and replaced it by similar limestone fragments taken from the bed of the brook and devoid of plant growth that could be detected. After 3 years thalli of *Endocarpon pusillum* 0.2 to 2 mm. across were found in con-

[10] See Kentucky, area 6, p. 142.

siderable abundance on one of the rocks and more sparingly on others. Other thalli were supposed to be the same, but were too immature to be determined. Over most of the replaced portion of the levee, the thalli could be seen only under the hand lens; but at a few points, the darker coloration of the rock could be detected in passing. None of the plants bore apothecia. After 4 years a few of the thalli of *Endocarpon pusillum* showed apothecia; and hundreds of apothecia of *Placodium aurellum* were scattered over some of the rocks. After 6 years the *Endocarpon* had developed many apothecia; and one could easily detect the coloration of the rocks, due to its thallus, from a standing position 8 m. distant. The *Placodium* apothecia had not increased greatly in number. Eight apothecia of *Lecanora dispersa* were seen on one rock. After 8 years the coloration due to the *Endocarpon* thallus could be seen easily over much of the rock when standing 20 m. distant. The apothecia of the *Placodium* were much more numerous, but would be noticed only under the hand lens. The apothecia of the *Lecanora* were still rare and, excepting one group which was easily visible from a standing position, were readily visible only under a hand lens. The thalli of the last 2 lichens could be seen only by aid of the lens.

Ohio, area 12, a soil quadrat 1 m. square on high ground in an open wood, denuded 5 cm. deep, removing all plant parts, except roots of seed plants which extended deeper into the soil and could not be pulled out. The quadrat, before being denuded, was covered by lichens and mosses, with about 85 herbs and 2 seedling trees scattered about within its limits. *Cladonia furcata* was the only abundant lichen. *Cladonia pyxidata* was present in several small patches, and a small cluster of *Cladonia mitrula* was seen. After 1 year 36 clusters of *Cladoniae* were noted within the quadrat, all so small as to be visible only on careful observation and too rudimentary to be determined. Herbs, mosses, and seedling trees were also appearing. After 5 years the quadrat had reverted to the conditions found in the surrounding area so far as the lichens were concerned. *Cladonia furcata* was again dominant and of the same size and appearance within as without the quadrat.

Kentucky, area 26, habitat like Kentucky, area 25,[11] a soil

[11] See Kentucky, area 25, p. 148.

quadrat 3 by 7 dm., denuded 5 cm. deep, removing the lichens and the superficial portions of the *Polytrichum* on which these were growing. *Cladonia pyxidata* and *C. cristatella* were abundant, and 4 other *Cladoniae* were seen in small quantities. After 2 months many small *Cladonia* squamules were observed in the quadrat. After 4 years a considerable number of specimens of *Cladonia pyxidata* of normal size were observed. After 8 years the quadrat had reverted to the conditions surrounding it. *Cladonia pyxidata* was abundant with 300 podetia within the quadrat. More than 30 podetia bore apothecia. A small amount of *Cladonia cristatella* was present and bore apothecia sparingly. Smaller amounts of 3 or 4 other *Cladoniae* were seen.

Kentucky, area 5, habitat like Kentucky, area 3,[12] a quadrat 4.5 by 5.5 cm., denuded 2 to 10 mm. deep. The quadrat was covered by *Cladonia subsquamosa,* which also grew on the surrounding rock. After 10 months *Cladonia* squamules were detected in considerable number within the quadrat. After 4 years the squamules had increased considerably in size and number. After 8 years squamules of normal size covered one-fourth of the quadrat and bore 20 fully developed podetia. Nearly all of these podetia bore apothecia. Many smaller pedetia were seen.

Kentucky, area 28, habitat similar to Kentucky, area 27,[13] but back 1 m. from the edge of the cliff where more shaded. A quadrat 3 by 4 dm. on soil 3 dm. or more deep was denuded 4.5 cm. deep. *Cladonia pyxidata* and *C. cristatella* in large quantity and *Cladonia verticillata* and *C. squamosa* in small quantity nearly covered the mossy substratum. A small amount of *Polytrichum,* a half dozen low huckleberry bushes, 3 or 4 clumps of grass, and a few other herbs were present. All plant parts were removed from the quadrat, except such roots as extended below the depth of denudation and could not be pulled out. After 10 months many small *Cladonia* squamules were found growing within the quadrat, and about the margin were clusters of larger squamules which bore podetia. These had been carried into the quadrat in some manner. After 4 years *Cladonia pyxidata* was present in large quantity. The squamules were scattered over the whole quadrat, and a considerable number of podetia of normal size

[12] See Kentucky, area 3, p. 142.

[13] See Kentucky, area 27, p. 145.

were present. The other *Cladoniae* were present in small numbers.

Kentucky, area 29, habitat similar to Kentucky, area 28,[14] but 10 m. distant from this and 3.5 m. back from the edge of the cliff in soil of considerable depth. A quadrat 4 dm. square was denuded 5 cm. deep. Growing in the quadrat were 3 greenbriers, 3 huckleberry bushes, 2 seeding pines, a few clumps of grass, a conspicuous covering of *Cladonia cariosa* with few podetia and apothecia, and a few well-developed plants of *Cladonia cristatella* and *C. uncialis*. After 10 months many small *Cladonia* squamules were found scattered over the quadrat. After 4 years the squamules were of larger size. After 8 years the squamules had covered a large proportion of the quadrat, and 25 podetia of *Cladonia cariosa* were counted, some of which were of normal size.

Ohio, area 9, on a new plane-tree board, next to the top in a fence on dry ground and exposed to the sun. The new board was placed in the fence 3 weeks before the study was begun, and the old boards above and below the new one were covered along the top edge and the sides by *Placodium microphyllinum*. After 2 years 15 minute areas of the *Placodium* thallus were visible to the eye on the top edge of the new board, the largest area being 1 mm. across. After 3 years hundreds of areas of the thallus were seen scattered over the whole top of the board, some barely visible to the eye, others reaching 0.5 cm. across, while the smallest were visible only under the hand lens. After 4 years the areas of thallus were more numerous and larger, and an examination of the whole length of the board with the hand lens resulted in finding 2 young apothecia, one of them with the disk open. After 6 years the thallus was as abundant and as fully developed on the top edge of the board as on the old boards and could be seen 20 m. distant. There were also a few small areas of the thallus on the sides of the new board near the top edge at this time. The lowest of these was 5 cm. down from the edge. Eleven apothecia were found at this time. After 8 years the apothecia were as frequent on the top edge of the new board as on the old boards. The thallus was not distinctly more abundant on the new board than it was at 6 years.

[14] See Kentucky, area 28, p. 154.

SUMMARY

One may speculate about possible or probable methods of migration to the denuded quadrats; but nothing is definitely known further than seeing parts of *Cladonia* thalli lying on some of the quadrats in early stages of ecesis. Other possible methods are through fragmentation, through soredia, and through spores. Some probable speculations regarding the means of ecesis might have been made for some of the studies, but this would have been scarcely worth while in the absence of definite data.

Many of the results recorded above cannot be summarized readily, and one must refer to the various studies for such data. Of data which are readily summarizable, the more important are given below.

Graphis scripta increased in diameter from 0.2 to 0.75 cm. in 1 year. *Verrucaria muralis* increased in diameter 0.6 cm. in 1 year. *Physica pulverulenta* increased in diameter for 7 years at the rate of 0.42 cm. per year. *Parmelia borreri* increased in diameter 1.3 cm. in 1 year. *Parmelia caperata* increased in diameter from 0.625 to 1.3 cm. per year for 8 years. *Parmelia conspersa* increased in diameter for 7 years at the average rate of 1.16 cm. per year. *Umbilicaria pustulata* increased in diameter for 8 years at the average rate of 0.36 cm. per year. *Peltigera canina* grew 1.75 cm. in one direction in 1 year.

Biatorella simplex replaced apothecia removed from sandstone conglomerate in 4 years, and sterile *Psora russellii* growing on limestone produced apothecia in the same time. An area of *Peltigera canina* deprived of its apothecia produced 12 young ones in 1 year. Smooth and sterile plants of *Umbilicaria pustulata* growing on high sandstone became strongly pustulate and produced apothecia in 7 years. *Cladonia subsquamosa* on sandstone conglomerate, when deprived of its podetia, regenerated them or produced others in 4 years. The same plant removed from the sandstone conglomerate, except minute fragments, produced squamules of normal size in 4 years and podetia of normal size in 8 years. *Cladonia pityrea* on rails, deprived of its podetia and squamules, except minute fragments, produced normal squamules in 1 year and numerous podetia in 3 years. *Cladonia*

uncialis in a denuded quadrat on thin soil regenerated new plants of full size in 4 years, from fragments thrown over the quadrat.

Verrucaria nigrescens became established in a denuded limestone quadrat and produced apothecia in 6 years. *Placodium aurellum* became established on limestone and produced apothecia in 4 years. *Placodium microphyllinum* became established on a new plane-tree board in 2 years and produced apothecia in 6 years. *Lecanora dispersa* became established on limestone and produced apothecia in 6 years. *Pyrenopsis schaereri* and *Collema pustulatum* became established on denuded limestone in 8 years, and *Placodium sideritis* became established and produced apothecia in the same time. *Pannaria nigra* became established and produced apothecia on denuded limestone in 7 years. *Endocarpon pusillum* grew and became established and produced apothecia on limestone in 4 years. *Amphiloma lanuginosum* became established on denuded sandstone conglomerate and was plainly visible after 4 years. *Cladonia pyxidata, C. fimbriata,* and *C. mitrula* became established on soil in a denuded quadrat and reached normal size in 5 years. *Cladonia pyxidata* and *C. cristatella* became established on denuded rock and produced podetia and apothecia of normal size in 8 years. *Cladonia subsquamosa* became established on denuded sandstone conglomerate and produced podetia and apothecia of normal size in 8 years.

Certain crustose lichens become established and produce thalli and apothecia in denuded areas in 2 to 8 years. Foliose lichens increase in diameter from 0.3 to 3.5 cm. per year. *Cladoniae* regenerate squamules in one or two years and podetia in 3 or 4 years, and these plants become established by succession in 4 to 8 years.

So far as external appearance goes, lichens produce apothecia in their natural habitats in 1 to 8 years; but, except in instances of primary succession, it is not certain but that the primordia of apothecia were present within the thalli at the time that the various studies given herein were begun. From the studies of primary succession, it would seem that the full development of apothecia to the point when they assume their mature form requires from 4 to 8 years when the plants are growing in their natural habitats.

However, much shorter times have been recorded for development in cultures.

Other similar data could be summarized. However, they would scarcely add to the conclusions regarding the rate of growth and ecesis in lichens, a subject about which so little has been known that one could scarcely form any opinion based on knowledge.

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TENNESSEE AND KENTUCKY FUNGI

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The fungous flora of Tennessee and Kentucky has not been studied to the same extent as that of many other states. The main work so far seems to have been limited to the more important disease-producing species on cultivated plants. In addition, collections have been made in a few special groups confined to the eastern mountains. The general flora of the central and western portions of these states remain practically untouched.

During the month of September, 1916, the writer, accompanied by Mr. Frank B. Cotner as assistant, visited two localities. One week was spent at Harlan, Kentucky, and three weeks at Elkmont, Tennessee, in the heart of the western slopes of the Big Smoky Mountains. The latter region is not far remote from the Asheville region of North Carolina where so many eminent mycologists have collected and whose flora is quite well known. Many species were therefore found which are known from the ranges east of the Big Smoky.

The most important condition for the study of the fungous flora of a region is of course the weather. Heavy rains had fallen in Elkmont during July and August, so that the wood-inhabiting fungi were still rather plentiful. The species growing on the ground, however, were not in sufficient abundance to give any satisfactory idea of the flora, as the rains during our stay were few and scattered, and the summer fruiting species had all been stimulated by the heavy rains to early fruiting. The following list of agarics, for example, although not small, represents in each case a small number of individuals collected, giving no hint of the frequency of the species for the region.

Since the larger part of the list below comes from Elkmont, Tennessee, the species from Harlan, Kentucky, will be marked by an asterisk and those common to the two localities by a double asterisk.

PHYCOMYCETES

**Synchytrium decipiens* Farl. On *Amphicarpaea monoica.*
**Cystopus Convolvulacearum* Otth. On *Ipomoea purpureum.*

ASCOMYCETES

GEOGLOSSACEAE

Geoglossum difforme (Fr.) Durand.
Geoglossum fallax Durand.
Geoglossum nigritum Cooke.
Trichoglossum Walteri (Berk.) Durand.
Leotia lubrica Pers.
Leotia stipitata (Bosc.) Schroet.
**Microglossum rufum* (Schw.) Underw.

HELVELLACEAE

Helvella atra König.
Helvella lacunosa Afzel.

PEZIZACEAE

Lachnea hemispherica (Wigg.) Gill.
Lachnea scutellata Gill.
Macropodia macropus Fuckel.
Plicaria vesiculosa Bull.

HALOTIACEAE

Chlorosplenium aeruginosum (Oed.) De Not.
**Chlorosplenium versiforme* De Not.
**Sarcascypha occidentalis* Schw.
**Geopyxis nebulosa* (Cooke) Sacc.

CENANGIACEAE

***Sarcosoma carolinianum* Durand. The ascospores of this species are slightly smaller than required, measuring 22–28 × 10–12 μ. It was found several times both on wood and decaying leaves.

HYSTERIACEAE

**Glonium stellatum* Muhl.

ERYSIPHOCEAE

Microsphaera Vaccinii (Schw.) C. & P.

HYPOCREACEAE

Cordyceps ophioglossoides Lk.
***Cordyceps militaris* (L.) Lk.
Hypocrea pallida Fr.
Hypocrea patella Cooke & Pk.
Hyphomyces aurantiacum (Pers.) Tul.
***Podostroma alutacea* (Pers.) Atk.
Chromocreopsis cubispora (Ellis & Holw.) Seaver.

Although the plants found differ in size, shape, and habit from the description of the above species it is not different. The stromata are caespitose-connate or confluent, forming tubercular masses 1–1.5 cm. high and as much as 2 cm. broad, empire-yellow (Ridg.) within and without, the parts sub-pyriform, *i. e.*, narrowed to the base, obtuse-rounded above, glabrous, punctate by the slender projecting dark olive ostioles; asci 8-spored, sp. pt. 50–55 × 5–6 μ; spores cuboidal, 5–6 × 4–5 μ, dark-olive; spore-print blackish-olive. On old logs.

Nectra cinnabarina Fr.

SPHAERIACEAE

Melanomma verrucaris (Fr.) Sacc.

DIATRYPACEAE

**Diatrype stigma* De Not.
**Diatrype virescens* Schw.
**Diatrypella favacea* (Fr.) Nitsche.

VALSACEAE

**Eutypella glandulosa* (Cooke) Ellis.

MELOGRAMMATACEAE

**Valsaria exasperans* (Gerard) Ellis. More properly *Myrmaecium exasperans* (Gerard). Syn: *Diatrype quadrata*, etc.

XYLARIACEAE

**Daldinia concentrica* Ces. & De Not.
Hypoxylon coccinea Bull.
**Hypoxylon cohaerens* Muhl.
**Hypoxylon Howeianum* Pk.
**Hypoxylon rubiginosum* Fr.
Xylaria digitata Grev.
**Xylaria polymorpha* (Schroet.) Grev.

UREDINALES

MELAMPSORACEAE

**Coleosporium Campanulae* (Pers.) Lev. On *Campanula americana.*
Coleosporium inconspicuum (Long) H. & L. On *Coreopsis major.*
Coleosporium Ipomeae (Schw.) Burr.
***Coleosporium Solidaginis* (Schw.) Thüm. On *Solidago* ssp.
***Coleosporium Vernoniae* B. & C. On *Vernonia* sp.
**Pucciniastrum Hydrangeae* (B. & C.) Arth. On *Hydrangea arborescens.*

PUCCINIACEAE

Puccinia atropuncta Pk. & Clint. On *Melanthium parviflorum.*
**Puccinia Circaeae* Pers. On *Circaea intermedia.*
**Puccinia Helianthi* Schw. On *Helianthus microcephalus.*

**Puccinia Menthae,* forma *americana* Burr. On *Cunila origanoides.*
Puccinia Smilicis Schw. On *Smilax rotundifolia.*
**Uromyces appendiculata* (Pers.) Lk. On *Phaseolus vulgaris.*
**Uromyces Euphorbiae* C. & P. On *Euphorbia Preslii.*
**Uromyces Hyperici* (Schw.) Curt. On *Hypericum* sp.
Uromyces Lespedezae-procumbentis (Schw.) Curt. On *Lespedeza* ssp.

BASIDIOMYCETES

THELEPHORACEAE (*fide Burt.*)

Corticium albulum Atk. & Burt.
Corticium alutaceum (Schrad.) Brid.
**Corticium polyporideum* B. & C.
***Craterellus odoratus* Schw.
Hymenochaete agglutinans Ell.
Hymenochaete Curtisii (Berk.).
***Hymenochaete tabacina* Fr.
**Hymenochaete purpurea* Cooke.
***Hymenochaete rubiginosa* (Dicks.) Lév.
**Peniophora Allescheri* Bres.
***Peniophora cinerea* Fr.
**Peniophora isabellina* Burt.
Peniophora velutina (D. C.).
Sebacina incrustans (Pers.) Tul.
**Solenia confusa* Bres.
**Stereum bicolor* Fr.
Stereum cinerascens (Schw.).
***Stereum frustulosum* Fr.
Stereum hirsutum Fr.
**Stereum lobatum* Fr.
Stereum ochraceoflavum Schw.
***Stereum rameale* Schw.
Stereum sanguinolentum Fr.
***Stereum sericeum* Fr.
Stereum sulcatum Burt.
Stereum tuberculosum Fr.
Thelephora albidobrunneus Schw.
Thelophora humicola Burt.
Thelephora regularis Schw.
**Tremellodendron candidum* (Schw.).

HYDNACEAE

***Irpex cinnamomeus* Fr.
***Irpex farinaceus* Fr.
Irpex tulipifera Schw.
Hydnum adustum Schw.
Hydnum albidum Pk.
Hydnum coralloides Fr.
**Hydnum ferruginosum* Fr.
***Hydnum ochraceum* Fr.
Hydnum putidum Atk.
**Hydnum pulcherrimum* B. & C.
Hydnum scrobiculatum Fr.
Hydnum septentrionale Fr.
Hydnum repandum Fr.
***Hydnum velutinum* Fr.
Odontia Wrightii B. & C.
Phlebia albida Fr.
Phlebia radiata Fr.

CLAVARIACEAE

Clavaria asperula Atk.
Clavaria curtus Fr.
***Clavaria flava* Fr.
Clavaria fusiformis Fr.
Clavaria mucida Fr.
Clavaria pistillaris Fr.
Clavaria pulchra Pk.
Clavaria pyxidata Fr.
Clavaria rugosa Fr.
***Clavaria stricta* Fr.

POLYPORACEAE

Boletus bicolor Pk.
Boletus castaneus Fr.
Boletus granulatus Fr.
Boletus luridus Fr.

Boletus luteus Fr.
****Boletus ornatipes*** Pk.
Boletus retipes B. & C.
****Fistulina hepatica*** Fr.
****Fomes applanatus*** Fr.
Fomes conchatus Fr.
****Fomes connatus*** Fr.
Fomes fomentarius Fr.
Fomes pinicola Fr.
****Fomes rimosus*** Berk.
****Polyporus adustus*** Fr.
****Polyporus albellus*** Pk.
Polyporus benzoinus Fr.
Polyporus Berkeleyi Fr.
Polyporus caesius Fr.
Polyporus chioneus Fr.
Polyporus confluens A. & S.
Polyporus cristatus Fr.
****Polyporus cuticularis*** Fr.
****Polyporus elegans*** Fr.
****Polyporus fissilis*** B. & C.
Polyporus floriformis Bres. fide Lloyd.
****Polyporus galactinus*** Berk.
****Polyporus gilvus*** Fr.
Polyporus guttulatus Pk.
****Polyporus lucidus*** Fr.
Polyporus Peckianus B. & C. fide Lloyd.
Polyporus picipes Fr.
****Polyporus Pilotae*** Schw.
Polyporus resinosus Fr.
Polyporus semisupinus B. & C.
Polyporus Spraguei B. & C.
Polyporus spumeus Fr.
****Polyporus sulphureus*** Fr.
Polystictus barbatulus Fr.
Polystictus biformis Klotsch.
Polystictus haedinus Berk. fide Lloyd.
Polystictus hirsutellus Schw. fide Lloyd.
Polystictus hirsutus Fr.
****Polystictus pergamenus*** Fr.
****Polystictus sanguineus*** Fr.
Polystictus velutinus Fr.
Polystictus versicolor Fr.
Porothelium fimbriatum Fr.
Poria attenuata Pk.
Poria ambigua Bres.
Poria betulina (Murr.).
****Poria cinerea*** Schw.
****Poria ferruginosa*** Fr.
Poria medullae-panis Fr.
Poria nitida Fr.
Poria pulchella Pk.
Poria purpurea Fr.
Poria semitincta Pk.
****Poria subacida*** Pk.
Poria sulphurella Pk. fide Lloyd.
Poria undata (Pers.) fide Lloyd.
Poria vaporarius Fr.
Poria vitellina Schw. fide Lloyd.
Poria vulgaris Fr.
Poria Xantha Fr.
Poria spp.
Gloeoporus dichrous (Fr.).
Trametes carnea Cooke.
Trametes mollis Fr.
Trametes robiniophila Murr.
Trametes sepium Fr.
Trametes serpens Fr.
Daedalea ambigua Berk.
****Daedalea confragosa*** Fr.
Daedalea unicolor Fr.
****Favolus europaeus*** Fr.
Favolus Rhipidium Berk.
Merulius corium Fr.
Merulius molluscus Fr.
Merulius rubellus Pk.
Merulius tremellosus Fr.
Merulius subaurantiacus Pk.
****Lenzites betulina*** Fr.
****Lenzites sepiaria*** Fr.
****Lenzites vialis*** Pk.

AGARICACEAE

****Amanita flavoconia*** Atk.
Amanita mappa Fr.
Amanita muscaria Fr.
Amanita rubescens Fr.
Amanita solitaria Fr.
Amanita tomentella Kromb.

****Amanita verna** Fr.
Amanitopsis vaginata Roze.
Amanitopsis farinosa Schw.
Armillaria mellea Fr.
***Collybia abundans** Pk.
Collybia butyracea Fr.
***Collybia confluens** Fr.
Collybia dryophila Fr.
Collybia familia Pk.
****Collybia myriadophylla** Pk.
****Collybia platyphylla** Fr.
****Collybia radicata** Fr.
Collybia strictipes Pk.
***Collybia zonata** Pk.

Collybia conigenoides Ellis. This is apparently a good species. Bresadola in Fung. Trid. II. p. 48 and 86, gives spore measurements of *C. esculenta* Wulf. and *C. conigena* Pers. as oblong, 6–8 × 3–4 μ. The Tennessee species is quite common on fallen and old Magnolia cones. Pileus 6–12 mm. broad, whitish or "cinnamon-buff" (Ridg.), striate; gills adnexed, close; stems elongated where they arise from buried cones, and hairy as in *C. conigena*, almost filiform, toughish and flexuous; spores ovoid, white in mass, smooth, 4–5.5 × 3 μ; cystidia ventricose, scattered on sides of gills, 45–55 × 12–15 μ, more abundant and flask-shaped on the edges, causing the pruinosity of the gills.

Cantherellus cinnabarinus Schw.
****Cantherellus cibarius** Fr.
Cantherellus floccosus Schw.
Cantherellus tubaeformis Fr.
Clitocybe cyathiformis Fr.
Clitocybe ectypoides Pk.
Clitocybe illudens Schw.
Clitocybe laccata Fr.
Clitocybe ochropurpurea B. & C.
Clitocybe piceina Pk.
Cortinarius alboviolaceus Fr.
Cortinarius bolaris Fr.
Cortinarius corruscans Fr.
Cortinarius flavifolius Pk.
Cortinarius infractus Fr.
Cortinarius hemitrichus Fr.
Cortinarius largus Fr.
Cortinarius lilacinus Pk.
Cortinarius rigens Fr.
Cortinarius torvus Fr.
Crepidotus applanatus Fr.

Claudopus variabilis Fr. In exact agreement with the description of Fries. *C. depluens* has angular spores, but Ricken seems to have confused the two species. Spores 10–12 × 5–6 μ, ellipsoid.

Clitopilus abortivus Fr.
Clitopilus orcella Fr.
Entoloma clypeatum Fr.
Entoloma griseum Pk.
Entoloma sericellum Fr.
Entoloma sericatum Britz.
Entoloma speculum Fr.
Hebeloma crustuliniforme Fr.
Hygrophorus ceraceus Fr.
Hygrophorus chlorophanus Fr.
****Hygrophorus marginatus** Pk.
Hygrophorus miniatus Fr. and var. *squamulosus* Pk.
Hygrophorus Peckii Atk.
Hygrophorus pratensis Fr.
Hygrophorus psittacinus Fr.
****Hypholoma capnoides** Fr. var. *alleghaniensis* var. nov.
Inocybe Cookei Bres.

Inocybe destricta Fr.
Inocybe geophila Fr.
Inocybe pallidipes E. & E.
Inocybe praetervisa Quél.
Inocybe rimosa Fr.
Inocybe subochracea var. *Burtii* Pk.
Inocybe trechispora Berk.
Lactarius alpinus Pk.
Lactarius cinereus Pk.
****Lactarius corrugis* Pk.
****Lactarius griseus* Pk.
Lactarius lignyotus Fr.
****Lactarius piperatus* Fr.
Lactarius Peckii Burl.
Lactarius subdulcis Fr.
Lactarius subpurpureus Fr.
Lactarius theiogalus Fr.
Lactarius trivialis Fr.
Lactarius volemus Fr.
Lepiota acutaesquamosa Fr.
Lepiota adnatifolia Pk.
Lepiota asperula Atk.
***Lepiota cepaestipes* Fr.
Lepiota clypeolaria Fr.
Lepiota granosa Morg.
Leptonia lampropoda Fr.
***Marasmius resinosus* Fr.
****Marasmius siccus* Schw.
Mycena cohaerens Fr.
Mycena epipterygia Fr.
***Mycena Leaiana* B. & C.
Mycena sanguinolenta Fr.
Nolanea dysthales (Pk.).
****Panus angustatus* Berk.
****Panus stipticus* Fr.
Panaeolus solidipes Pk.
****Paxillus corrugatus* Atk.
Paxillus panuoides Fr.
Paxillus rhodoxanthus Schw.
Pholiota aggericola Pk.
Pholiota flammans Fr.
Pholiota lutea Pk.
****Pholiota squarrosoides* Pk.
***Pleurotus applicatus* Fr.
****Pleurotus sapidus* Fr.
****Pluteus cervinus* Fr.
Pluteus nanus Fr.
****Psalliota placomyces* Pk.
****Psathyrella disseminata* Fr.
Russula delica Fr.
****Russula emetica* Fr.
****Russula fragilis* Fr.
Russula foetens Fr.
Russula flavida Frost.
Russula flava Romell.
Russula ochrophylla Pk.
Russula squalida Pk.
***Russula uncialis* Pk.
Russula variata Banning.
Russula virescens Fr.

Russula ochroleucoides sp. nov.

Pileus 6–12 cm. broad, large, rigid, convex, soon expanded plane, varying straw-yellow to pale-ochraceous, usually dull-ocher to reddish-ocher toward center, pellicle adnate, soon dry and pulverulent to subrimose, even on the obtuse margin; flesh thick, compact, white, unchanging or slightly sordid in age; gills adnexed or free, rather narrow, rounded and broader in front, white or whitish, close to subdistant, shorter ones intermingled, often forked behind, intervenous; stem 4–6 cm. long, 1.5–2 cm. thick, short, rigid, equal or tapering slightly downward, white, glabrous or subpruinose, spongy-solid; spores even or minutely rough, 7–9 μ (incl. apiculus), white in mass; cystidia very few; basidia about 40 × 9 μ; taste tardily and slightly bitterish-acrid to disagreeably bitter; odor faintly aromatic or none.

Gregarious, on the ground in woods of deciduous trees. Infrequent. Elkmont, Tennessee, and Ann Arbor, Michigan. This seems to be a rather rare species and was found only three times. Although similar to *R. ochroleuca* in colors, it departs widely by belonging to the Rigidae, near *R. virescens*.

****Schizophyllum commune* Fr.

Stropharia caesiospora sp. nov.

Pileus 4–9 cm. broad, convex, obtuse, chamois to honey-yellow (Ridg.), subviscid, even, firm or slightly elastic, margin somewhat crenate-lobed; flesh white, rather thick and compact, thin on margin; gills crowded, narrow, adnexed-emarginate, at length rounded behind, heterophyllous, drab to hair-brown or ashy-gray; stem 4–9 cm. long, equal or slightly bulbous at the base, whitish, 6–12 mm. thick, slightly lacerate above the annulus, stuffed to solid, fibrillose-glabrescent; annulus persistent, membranous, flocculose below, striate-ridged above, becoming gray from the spores; spores minute, 5–6 × 3–4 μ, ovoid, smooth, tinged purplish-cinereous under microscope, ashy in mass with a tint of purple; cystidia none, except few, inflated, sterile cells on edge of gills; odor slight.

Gregarious, on the ground among debris in chestnut and conifer mixed woods, Elkmont, Tennessee, September, 1916. The color of the half-mature gills is similar to that of *S. depilata* Fr., but paler. The annulus has the markings of *S. coronilla* Fr. and of *S. bilamellata* Pk., which differ in spore-size. It is near to the description of *S. obdurata*, which Ricken considers identical with *S. coronilla*. It was found a number of times.

Tricholoma album Fr.
Tricholoma personatum Fr.
Tricholoma rutilans Fr.
Tricholoma sejunctum Fr.
Tricholoma sulphureum Fr.

TREMELLALES

Tremella albida Huds.
Tremellodon gelatinosum Fr.
Calocera viscosa Fr.

GASTEROMYCETES

Astraeus stellatus (Scop.) E. Fischer
Calostoma cinnabarinus Desv.
Calvatia cyathiforme (Bosc).
Cyathus striatus (Huds.) Hoff.
**Geaster triplex* Jung.
Geaster saccatus Fr.
Lycoperdon gemmatum Batsch.
Lycoperdon pyriforme (Schoeff.) Fr.
***Lycoperdon subincarnatum* Pk.
Scleroderma Geaster Fr.
**Scleroderma tenerum* Berk.
***Scleroderma vulgare* Fr.

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NEW JAPANESE FUNGI

NOTES AND TRANSLATIONS—I

TYÔZABÛRO TANAKA

This is the first of a series of papers prepared for the purpose of supplying prompt and full information regarding newly discovered Japanese fungi that have been described only in Japanese. Descriptions of new species of fungi, many of them of great economic importance, are appearing in many different publications in Japan, some of them difficult to obtain in the United States. New species which are published in Latin, English, or other European language will be merely cited if referred to at all. It is hoped that the information here presented will prove of interest and value to American and European mycologists and plant pathologists.

There are two lists of Japanese fungi published twelve and thirteen years ago, both including all species known from Japan at the time, one by Prof. J. Matsumura, Index plantarum japonicarum, Vol. 1. Cryptogamae (Fungi pp. 127–184) 8°, Tokyo Mar. 1904, giving an alphabetical list of species with synonomy, host plants and localities all in Latin; the other by Prof. M. Shirai, A List of Japanese Fungi hitherto known, 8°. Tokyo Nov. 1905, 156 pp., giving an alphabetical list of species with synonomy in Latin and the host plants in Japanese characters only. Localities are not given. The more important fungi causing plant diseases in Japan are treated by Prof. A. Ideta, Handbook of the Plant Diseases of Japan, 4 ed. 4°, Tokyo 1909–1911, 1104 pp. A 17-page index gives the Latin names of the fungi treated. Prof. Ideta is now writing a supplement bringing this work up to date.

VALSA (EUVALSA) PAULOWNIAE Miyabe and Hemmi, sp. nov. in Byôchû-gai Zasshi (Journal of Plant Protection) 3[9]: 681–689. 1 pl. Sept., 1916. (Japanese.)

This fungus attacks the Paulownia tree first on the twigs and

then spreads over the branches, finally covering the entire tree down to the roots. The infection occurs in winter and early spring, mostly on the wounded or dead part of shoots, which gradually become rough, dry and brown, and finally crack with irregular elevated spots appearing on the surface—the stromata of the fungus. Loose mycelia from the stroma connect the tissues of the host and the fungus bodies. The pycnidia first appear on the stromata as depressed globular flasks, $1.5 \times .6$ mm., with colorless, obtuse, slightly curved pycnospores $2.85–8.75 \times 0.88–1.75\,\mu$ on short, branched conidiophores. The perithecia, arranged at the bottom of stroma, 15–16 in one group, are flask-shaped with long necks about twice or three times the length of the perithecial body which measures $150–300\,\mu$ in diameter; asci very fragile, soon disappearing, cylindric or clavate, more or less curved, sessile or very short stalked, $32–52 \times 8–10\,\mu$ octospored; ascospores generally in two rows, occasionally irregular or one row, cylindric, obtuse, curved, smooth, hyaline, very slightly pale brownish when mature, $10–18 \times 2–4\,\mu$, germinating in 20–24 hours, either in distilled water or on culture media.

This "Tachigare" or dieback disease first appeared in Hokkaidô about 1910 and seriously damaged Paulownia, first in 1913 and 1914 when many old trees were killed. In 1915 the disease spread all over Hokkaidô, and in one case about 3,000 trees at the same place were attacked.

For its prevention the trunks of the trees should be wrapped with straw in winter so as to prevent freezing or wounding. Bordeaux mixture should be used as a spray on the trees in early spring.

OPHIOCHAETA GRAMINIS (Sacc.) K. Hara n. comb. in Byôchûgai Zasshi (Journ. of Plant Protection) 3^5: 342–345. May, 1916. (Japanese.)

This fungus, commonly called *Ophiobolus graminis*, is known as a cause of foot-rot of wheat and barley in France, Belgium, Germany, and Japan. The author discovered a similar disease on rice-plant caused by the same fungus which he proposes to transfer to Saccardo's genus Ophiochaeta, on account of the existence of bristle hairs on the perithecium. In the case of the fungus attacking the rice-plants the perithecia are somewhat smaller, *i. e.*, $240–480\,\mu$ diameter, and the ostiolum $12–280\,\mu$ in length and $7–8\,\mu$ across, but the asci and ascospores are nearly the same as described from other plants, *i. e.*, asci $80–120 \times 8.5–16\,\mu$ and ascospores $27.1–104 \times 3.2–4\,\mu$.

The author suggests four important factors in preventing the disease: (1) Selection of a resistant variety; (2) necessity of avoiding the use of too much nitrogen fertilizers; (3) not allowing too much water on the field; and finally (4) application of stable manure instead of mulching the field.

MARSONIA CARTHAMI T. Fukui sp. nov. in Nôgaku Kwaihô (Journ. of the Scientific Agricultural Society) No. 166, pp. 381–383, fig. 6. T. 5, vi. June, 1916. (Japanese.)

Spots ochre-brown, few, 1–10 rarely more, orbicular, elliptical or irregular, never angular, varying in size, the largest 10×6 mm., sometimes confluent, forming still larger spots, margin definite, raised, punctate with acervuli; acervuli subepidermal, scattered, brownish; conidiophores hyaline or pale yellowish, $20 \times 3\,\mu$; conidia hyaline or pale yellowish-brown, elliptic, ends acute especially the base, giving a fusiform appearance, contents granular at maturity, 1-septate, constricted at the septum, $10–25 \times 4–6\,\mu$, average $20 \times 5\,\mu$.

On living leaves of young plants of *Carthamus tinctorius* L. (Compositae) called in Japan *Benibana* (*Hung-hua*, in Chinese) found at the experiment farm of Shidzuoka-ken Agr. Experiment Station, Abegun, Shidzuoka-ken, Japan: Sept. (?), 1916.

MYCOSPHAERELLA HORDICOLA Hara sp. nov., ex Tsuruda, Shôitsu in Byôchû-gai Zasshi (Journ. of Plant Protection) 3^7: 532. July, 1916. (Japanese.)

Perithecia small, black, globular, $297 \times 212\,\mu$ or $255 \times 212\,\mu$ (figures doubtful); asci irregularly cylindrical or sometimes conical, octosporous; spores hyaline, fusiform, blunt at both ends, $7–15 \times 2.7–3.5\,\mu$, two-celled, contents granular. On the blades and culms of wheat, barley, and naked barley,

Differs from *Sphaerella bacicola* B. Frank which grows on rye and has perithecia with rosy interior and constricted elliptical spores which measure $10–12\,\mu$. This sp. is also distinct from *Mycosphaerella Hordei* Karst which has straight, elliptical or fusiform constricted spores, $18–24 \times 6–8\,\mu$.

Distribution: Shidzuoka-ken, Suntô-gun, Kanaoka-mura, May 24, 1916, S. Tsuruda; Agehara-mura, May 3, 1916, S. Tsuruda; Ukishima-mura, May 11, 1913, S. Tsuruda; Fuji-gun, Obuchi-mura, June 22, 1915, Takimura Nôkwai (Agr. Soc. of Taki-

mura); Inasa-gun, Iinoya-mura, April 13, 1914, S. Tsuruda; Aratama-mura, May, 1914, T. Okada.

New Japanese name of the disease: Mugi no Kangare-byô (Culm-rot disease of barley and wheat).

Local name of the disease: Mugi no Tachigare (Foot-rot or stem-rot of barley and wheat); Kuse (Bad-habit).

Notes: A barley variety "Dobu" seems resistant to the disease; on the other hand the variety "Oku-mikawa" is very susceptible. The disease is much less injurious when seeds are sown earlier than the usual planting time. The disease becomes virulent when nitrogenous fertilizers are used too freely. Phosphate is effective in strengthening the growth of the culm to withstand the disease. Lime, sulphur-flower, and Bordeaux mixture all lessen the damage done by this fungus.

SCORIAS CAPITATA K. Sawada sp. nov. in Nôjishikenjô Tokubetsu Hôkoku (Special Report, Agr. Exp. Station) Taiwan (Formosa), No. 11, pp. 123–124, pl. 4, fig. 19–23. T. 4, ii, Feb., 1915. (Japanese.)

Mycelia covering the upper surface of the leaves of *Thea sinensis* as a black mass, sometimes covering the lower surface and even the twigs, presenting a conspicuously rough or fuzzy appearance, which is caused by bundles of hyphae and slender perithecia which stand upright. Hyphae catenulate, soot color, 2.5–5 μ across; hyphae bundles (perithecial stalks) soot color, once or twice branched, of various forms but usually conical, cylindrical, fusiform or elliptical, frequently two joined together at the lower half, 110–247 $\times$ 52–75 μ, apically constricted terminated by perithecia; perithecia black, nearly ovate or orbicular, 60–83 $\times$ 50–78 μ, containing numerous asci; asci clavate, obtuse, hyaline, 30–35 $\times$ 9–12 μ, with 6–8 spores; spores fusiform to clavate-fusiform, obtuse at both ends, hyaline, 3-septate, 10–11.5 $\times$ 3–3.5 μ.

Type locality: Taihokuchô Chônaiho-shô, Formosa. Dec. 12, 1907, Y. Fujikuro.

ZUKALIA THEAE K. Sawada sp. nov. in Nôjishikenjô Tokubetsu Hôkoku (Special Report Agr. Exp. Station) Taiwan (Formosa) No. 11, p. 122, pl. 4, figs. 10–13. T. 4, ii, Feb., 1915. (Japanese.)

Perithecia black, globose, 67–135 μ in diameter; subiculum black.

hyphae filiform, at first pale, later brownish, branched, septate, 3–6 μ across; asci many, surrounded by 6–8 dark brown, blunt, 5–6-septate setae, 70–100 $\times$ 4 μ; asci 8-spored, hyaline, clavate, fusiform, 68–90 $\times$ 13–16 μ; spores hyaline, obovate elliptic to clavate, 3-septate, 17–23 $\times$ 6–7 μ.

On leaves and twigs of *Thea sinensis*.

Type locality: Shinchiku-chô, Sanshaka, Formosa, May 10, 1910, K. Sawada.

PESTALOZZIA THEAE K. Sawada sp. nov. in Nôjishikenjô Tokubetsu Hôkoku (Special Report Agr. Exp. Sta.), Taiwan (Formosa), No. 11, p. 113, pl. 4, figs. 7–9. T. 4, ii, Feb., 1915. (Japanese.)

Spots punctate with acervuli; acervuli at first subepidermal, later erumpent, finally exposed; mycelium penetrating the host, hyaline, branching, 2.5–3 μ in diam., mycelial tissue thin but composed of tightly woven hyphae; conidiophores caespitose, simple, short, filiform, 4–9 $\times$ 1 μ, fugacious; conidia fusiform, 4-septate, slightly constricted, 3 inner cells dark brown, 16–21 μ, basal and apical cells hyaline, 4–6 μ, setae 3–4, 28–36 $\times$ 1–2 μ, slightly swollen at the apex, hyaline.

On leaves of *Thea sinensis*. Diseased spots brown when young, when mature gray with brown margin, usually 1 cm. in diam., sometimes covering half of a leaf. Acervuli always appear on the concentric zone as black dots, but when they occur on the under surface of leaves, the zones are not always distinct and the dots are very few.

Type localities: Taihokuchô Zûihô, Jul. 4, 1909, Y. Fujikuro; Taihokuchô Kusshaku, Jul. 14, 1908, Y. Fujikuro; Taihokuchô Mokusaku, Sept. 30, 1908, Y. Fujikuro: Taihokuchô Shinten, Jul. 15, 1908, Y. Fujikuro; Taihokuchô, Rigyokutsu, Jul. 13, 1908, Y. Fujikuro; Taihokuchô, Hokuseiko, Jul. 9, 1907, R. Suzuki; Taihokuchô Chônaiho, Dec. 19, 1908, K. Sawada; Nov. 30, 1909, Y. Fujikuro, May 4, 1910, K. Sawada; Tôenchô Kessishô, Aug. 21, 1908, K. Sawada & Y. Fujikuro; Tôenchô Dôraken, Aug. 21, 1908, K. Sawada & Y. Fujikuro; Tôenchô Anheichin, Aug. 20, 1908, K. Sawada & Y. Fujikuro; Shinchikuchô Shinpo, May 6, 1910, Y. Fujikuro; Akôchô Kôkô, Jul. 8, 1910, K. Sawada.

SCLEROTINIA FAGOPYRI S. Hori sp. nov. in Byôchû-gai Zasshi (Journ. Plant Protection) 3^8: 171–175. Mar. 1916. (Japanese.)

Sclerotia orbicular, ellipsoid, oblong or ovoid, 2–3 × 2–4 mm., surface black, inner tissue rose colored; apothecia one or two from a sclerotium, cinnamon-brown, 3 mm. in diam., somewhat cupulate, stipitate, stipes 3–5 mm. in length; asci cylindrical, slightly curved, 135–155 × 9–11 μ; ascospores eight, obliquely monostichous, 11–14 × 6–8 μ, guttulate near each end; paraphyses filiform or clavate, slightly longer than the asci, 2–2.5 μ in diam., 2–4 (usually 2–3) septate.

The sclerotia form inside of the seeds of *Fagopyrum esculentum* and probably germinate twice a year. The diseased seeds sink in brine of 1.12 to 1.20 sp. gr., while healthy seeds float. They alone should be planted.

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.

NOTES AND BRIEF ARTICLES

Professor L. H. Pennington, of Syracuse University, visited the Garden on April 9 to consult the library and mycological herbarium.

Forsythia viridissima is subject to a disease of the flower stalks which, according to Peglion, is probably due to *Sclerotinia libertiana.*

A new disease of bamboo found by Turconi on the branches of *Bambusa mitis* in the botanical garden at Pavia is said to be due to *Melanconium Bambusae* sp. nov.

We are requested by Mr. E. Bartholomew to announce that the publication of "Fungi Columbiani" has been discontinued with the distribution of Century 51.

Professor H. S. Jackson, of Purdue University, Lafayette, Indiana, spent the week of April 16–21 at the Garden working on plant rusts in preparation of manuscript for a forthcoming part of *North American Flora.*

Professor Frederick E. Clements has resigned the chair of botany at the University of Minnesota to accept a position with the Carnegie Institution of Washington.

Mr. Ray Nelson, formerly assitant in the Michigan Agricultural College Experiment Station, has been appointed plant pathologist for the Illinois Central Railroad.

Mr. W. P. Fraser, plant pathologist of Macdonald College, has been appointed to investigate the problem of grain rust on the prairie provinces of Western Canada.

Professor C. H. Kauffman, of the University of Michigan, Ann Arbor, Michigan, spent several days at the Garden about the

middle of April studying the collections of *Inocybe* in preparation for the publication of this genus in *North American Flora*.

Mr. Lex Hesler, of Cornell University, has been granted a year's leave of absence to study plant diseases in Porto Rico. He sailed for Mayagüez on February 10.

Mr. H. E. Thomas, instructor in botany at the Virginia Polytechnic Institute, sailed on March 3, to Mayagüez, to take up work in plant pathology at the Federal Experiment Station, Porto Rico.

A wilt disease of the columbine has been traced by Taubenhaus to *Sclerotinia libertiana,* which attacks the crown and then the stem of the plant. The fungus winters over on dead plants, which show the sclerotia in large numbers.

Mr. C. G. Lloyd, of Cincinnati, has presented to the Garden a complete set of all known species of puffballs, based on his extensive and long-continued studies of this group. The value of this contribution can hardly be estimated.

Botryorhiza Hippocrateae and *Endophylloides portoricensis,* new genera and species of rusts, were described by E. W. Olive and H. H. Whetzel in the January number of the *American Journal of Botany* in an article on the *Endophyllum*-like rusts of Porto Rico.

L. M. Massey, in the Cornell University Agricultural Experiment Station Bulletin 380, gives the results of his rather extensive studies of the hard-rot disease of *Gladiolus* caused by *Septoria Gladioli* Passer. The methods of treating the disease are also considered.

Phymatotrichum omnivorum is the name used by Dr. B. M. Duggar for the fungus causing the cotton root rot which is common in many parts of Texas. An account of this disease was recently published in the *Annals of the Missouri Botanical Garden.*

Among fungi collected recently in China by Mr. Frank N. Meyer are specimens of *Cryptoporus volvatus* found on a dead trunk of *Pinus sinensis* at Ching lung shan, Chili Province. This interesting species has previously been collected in Japan.

Five new species of *Ravenelia* from Texas, Arizona, and Florida were recently published by W. H. Long in the *Botanical Gazette*. These species are as follows: *Ravenelia annulata, R. morongiae, R. reticulatae, R. roemerianae,* and *R. thornberiana.*

Dr. E. A. Burt has recently completed a study of the Thelephoraceae collected by W. A. Murrill in Mexico, and reports many interesting species, quite a number of which are new. These will be published in Dr. Burt's series of articles now appearing in the *Annals of the Missouri Botanical Garden.*

Helicosporium nymphaearum is described as new by Frederick V. Rand in the February number of the Journal of Agricultural Research. The fungus causes irregular spotting and decaying of the leaves of various species of pond lilies of the genus *Nymphaea.* Part of the material on which these studies were based was collected in the New York Botanical Garden, although the disease was first noted at Kenilworth, D. C.

Sorauer has recently made observations on house plants and finds that injury from burning gas in rooms is negligible and is easily avoided entirely by ventilation. The chief injuries are probably due to the elevation of temperature and the drying of the atmosphere by means of fires or heaters.

Pistillaria Thaxteri Burt, recently described as the smallest hymenomycete, was found by Professor Thaxter on rotten wood at Westhaven, Connecticut, about twenty-nine years ago. An account of this interesting little fungus appeared in the *Annals of the Missouri Botanical Garden* for November, 1916.

The genus *Hypochnus* is treated by Dr. E. A. Burt in the *Annals of the Missouri Botanical Garden* for April, 1916, 31

North American species being recognized, of which 13 are new and many are newly combined. The genus *Septobasidium* treated in the September number of the same volume contains 17 North American species, of which 10 are new.

Mushroom fairy rings of *Tricholoma praemagnum* found at several places in Colorado by Francis Ramaley were described and figured in *Torreya* for September, 1916, which number also contains a redescription of the species by L. O. Overholts. This large and interesting agaric was first described in *North American Flora* from Saskatchewan, Canada.

Entoloma cinchonense Murrill, described from Cinchona, Jamaica, in Mycologia **3**: 279. 1911, has been found to have hyaline spores and is therefore here newly combined as **Melanoleuca cinchonensis** Murrill. It is readily distinguished from other tropical American species of this genus by its small, ochroleucous pileus and salmon-colored, notched lamellae.

Professor George Massee, the well-known English mycologist, died on February 17 at the age of sixty-seven. Professor Massee was long connected with the Royal Botanic Garden at Kew and published many books and papers on mycology. His private collection of fungi and drawings was purchased by the New York Botanical Garden some years ago. He has been one of the associate editors of *Mycologia* since 1911.

Mr. Sanford M. Zeller has made an extensive physiological study of *Lenzites saepiaria* Fries with special reference to enzyme activity. An interesting experiment by Mr. Zeller shows that *L. saepiaria* will grow well on 50 per cent. resin by weight, which is considerably more than is found in any coniferous wood, and that growth of the fungus is not entirely inhibited by 85 per cent. resin.

Fine specimens of the common mushroom have been sent in by Dr. S. M. Stocker, of Duluth, Minnesota, exhibiting abnormal outgrowths of the fruiting surface on the top of the cap. The inverted hymenium is in many cases not strictly lamellate but

somewhat poroid and otherwise abnormal. This peculiarity is often exhibited by *Tricholoma personatum* and certain other wild agarics.

Dr. C. L. Shear visited the Garden on February 3 to consult the library and mycological collection. He then went with Professor J. C. Arthur to Philadelphia to examine the Schweinitz collection of fungi to determine how it might be made more available to American mycologists. Dr. Shear and Dr. Arthur are members of a committee appointed for this purpose by the American Phytopathological Society.

Mel T. Cook and G. W. Wilson have been investigating the effect of tannin on the growth of the chestnut canker fungus and they find that 0.8 per cent. or more causes a retardation of germination, which is frequently followed by an abnormal stimulation of the growth of the aerial mycelium. It was found that tannin is utilized by *Endothia parasitica,* the fungus being able to remove as much as 2 per cent. from the substratum.

Professor Ellsworth Bethel, of the State Museum, Denver, Colorado, has recently sent in a specimen of *Scutiger cryptopus,* which is the first I have seen from Colorado, the species having been found heretofore in Kansas and Nebraska, attached to dead grass roots in sandy pastures. The specimen sent by Professor Bethel grew in a field at Boulder, Colorado. Other specimens sent at the same time included *Lentodium squamosum, Polyporus elegans,* and *P. arcularius.*

Mr. E. D. Merrill, of the Bureau of Science, Manila, has recently sent to the Garden specimens of *Pachyma hoelen* Fries, purchased in a Chinese drug store in Hongkong by Mr. Tutcher, Director of the Hongkong Botanic Garden. This fungus is extensively cultivated on pine trees in central China. The following description by Fries was based on *Hoelen* of Rumphius, which was described from Chinese specimens.

"3. Hoelen. *Sinensium.* Oblongum, cortice rugoso, extus intusque sordide flavescens.

"Magnitudo capitis infantis. Medicamentum pretiosum, Theae instar, ad vires corrobandas, in Phtisi &c., usitatum. *Sub terra arenosa in China, provincia* Suchensi."

Farmers' Bulletin 789 of the U. S. Department of Agriculture treats of certain insects that attack mushrooms and the means of controlling them. The chief insects considered are maggots, mites, springtails, and sowbugs, the first class being the most important. The author, C. H. Popenoe, concludes that if the mushroom house is carefully constructed and all outlets closed or screened; if the spawn is purchased from reliable dealers; and if the compost is carefully prepared and kept at as low a temperature as possible, there should be little necessity for the radical measures of fumigation, sterilization, or destruction of the mushroom beds.

The report of the New York State Botanist for 1915 contains descriptions and notes of many new and interesting species of fungi, especially of those parasitic on leaves and twigs. Dr. House has been assisted by Professor Dearness in this publication. The following species are new: *Cercospora caricis, C. lathyri, Cucurbitaria ceanothi, Diaporthe minuta, Gloeosporium alnicola, G. falcatum, G. hydrophylli, Macrophoma viburni, Metasphaeria staphyleae, M. varia, Microdiplodia ceanothi, M. lophiostomoides, Phoma florida, P. galactis, P. linariae, P. pectinata, P. platanicola, Phyllosticta steironematis, Ramularia cichorii, Scolescosporium coryli, Septoria mollisia, S. tenuis, Sphaeropsis ceanothi, S. parallela, S. viburni-dentati, Stagonospora convolvuli, Dothidella vacciniicola.*

Three new polypores have just been published by W. H. Long in the first number of the *Papers of the New Mexico Chapter Phi Kappa Phi. Polyporus pseudosulphureus* was collected on live oak near Ocala, Florida, as well as from three other localities in Florida on the same host. *Fomes arctostaphyli,* which is said to be the smallest species of this genus with brown context yet reported from North America, was collected abundantly on *Arctostaphylos* at various places in Arizona. The author says it is very

common on manzanita in the vicinity of Sedona, where it attacks practically every bush of this host which is over an inch in diameter, causing a very characteristic heart-rot. *Polyporus piniponderosae* was collected on *Pinus ponderosa* near Albuquerque, New Mexico. It should be carefully compared with *Tyromyces Smallii* Murrill, which occurs on pine in Florida and Louisiana.

Melanoleuca pulverulentipes Murrill, sp. nov.

Pileus rather thick, convex to plane, becoming slightly umbilicate, solitary, 1.5–1.7 cm. broad; surface moist, hygrophanous, smooth, glabrous, somewhat mottled, fulvous, becoming isabelline on drying, margin incurved, frosted, entire, concolorous; lamellae sinuate, plane, crowded, ferruginous-melleous to ochroleucous, entire and concolorous on the edges; spores ellipsoid, smooth, hyaline, 5×2–$3\,\mu$; stipe subequal, tough, smooth, pale-fulvous or ochroleucous, finely pulverulent-fibrillose and ochraceous-melleous at the apex, whitish-mycelioid at the base, 1.5–2 cm. long, 2–4 mm. thick.

Type collected on the ground among mosses in woods at Lake Placid, Adirondack Mountains, New York, July 17–29, 1912, *W. A. & Edna L. Murrill 181* (herb. N. Y. Bot. Gard.).

HABITAT: On the ground in humus or among mosses.

DISTRIBUTION: Vicinity of Lake Placid, Adirondack Mountains, New York.

W. A. MURRILL.

THE ROSY-SPORED AGARICS

Volume 10, part 2, of *North American Flora*, by William A. Murrill, appeared April 25, 1917. The contents of this part may be indicated, as follows:

Genera	Total North American Species	New Species
Claudopus	9	1
Eccilia	25	9
Leptoniella	43	14
Nolanea	28	11
Pleuropus	30	5
Lepista	4	
Entoloma	63	34
Pluteus	57	30
Chamaeota	2	1
Volvariopsis	21	2
	282	107

For the accommodation of those preferring currently accepted generic names, the following new combinations are proposed for species described as new in *Leptoniella, Pleuropus, Chamaeota,* and *Volvariopsis:*

LEPTONIELLA ACERICOLA	= **Leptonia acericola**
LEPTONIELLA ALABAMENSIS	= **Leptonia alabamensis**
LEPTONIELLA ALBIDA	= **Leptonia albida**
LEPTONIELLA FULIGINOSA	= **Leptonia fuliginosa**
LEPTONIELLA GLABRA	= **Leptonia glabra**
LEPTONIELLA MULTICOLOR	= **Leptonia multicolor**
LEPTONIELLA MURINA	= **Leptonia murina**
LEPTONIELLA NIGRA	= **Leptonia nigra**
LEPTONIELLA OCCIDENTALIS	= **Leptonia occidentalis**
LEPTONIELLA ROSEIBRUNNEA	= **Leptonia roseibrunnea**
LEPTONIELLA SEMIGLOBATA	= **Leptonia semiglobata**
LEPTONIELLA SUBPLACIDA	= **Leptonia subplacida**
LEPTONIELLA SUBVILIS	= **Leptonia subvilis**
LEPTONIELLA UMBILICATA	= **Leptonia umbilicata**
LEPTONIELLA WHITEAE	= **Leptonia Whiteae**
PLEUROPUS ADNATIFOLIUS	= **Clitopilus adnatifolius**
PLEUROPUS AVELLANEUS	= **Clitopilus avellaneus**
PLEUROPUS CINEREICOLA	= **Clitopilus cinereicola**
PLEUROPUS LIGNICOLA	= **Clitopilus lignicola**
PLEUROPUS MAGNISPORUS	= **Clitopilus magnisporus**
PLEUROPUS MURINUS	= **Clitopilus murinus**
PLEUROPUS OBESUS	= **Clitopilus obesus**
PLEUROPUS SUBCINEREUS	= **Clitopilus subcinereus**
CHAMAEOTA BROADWAYI	= **Annularia Broadwayi**
VOLVARIOPSIS ALABAMENSIS	= **Volvaria alabamensis**
VOLVARIOPSIS EARLEAE	= **Volvaria Earleae**

Through an unfortunate error, *Leptoniella Earlei* was used for two distinct species. For the one on p. 90, **Leptoniella paludosa** nom. nov. is here proposed, or, for those following Saccardo, **Leptonia paludosa** comb. nov.

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